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Automotive Division

Jos. S. Hildreth, President and Manager

Julian Chase, Vice Pres. — **G. C. Buzby, Vice Pres.**

OFFICES

Philadelphia—Chestnut & 56th Sts., Phone Sherwood 1424
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IN THIS ISSUE . . .

AUTOMOTIVE and AVIATION INDUSTRIES

Volume 88 February 1, 1943 Number 3

AUTOMOTIVE INDUSTRIES

Reg. U. S. Pat. Off.

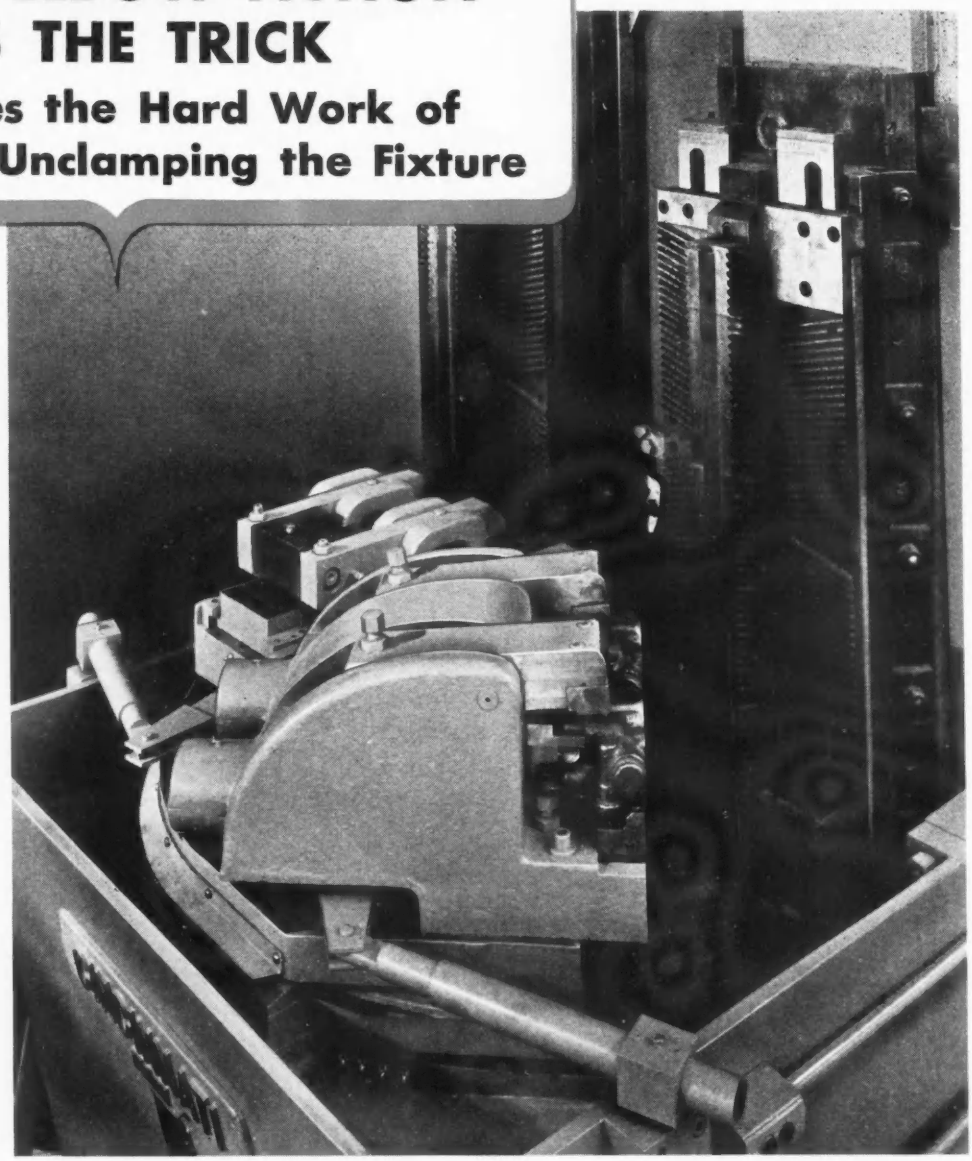
Automotive Factories Aid Scrap Metal Drive

Automotive factories supplied war industry with 716,978 tons of metal scrap in the first six months of the automotive industry's salvage drive, according to a report for the period ending in November made by the Automotive Council for War Production. Of this total, 674,965 tons, or 94 per cent, was iron and steel scrap, while the remainder was non-ferrous metals. Eighty-nine per cent of the automotive plant salvabe material was production scrap, while 77,191 tons, or 11 per cent, came from non-production sources, such as discarded tools, dies, machinery and other working equipment. More than 9000 tons of idle equipment were relegated to the nation's scrap pile.

November's salvage report by the ACWP showed recovery of 118,428 tons of iron and steel, 3442 tons of aluminum, 4556 tons of copper and brass, 791 tons of other metals and 239 tons of rubber. One company reported that by authorizing the scrapping of aluminum molds it released enough high-grade aluminum to fill five and one-half railroad freight cars.

NATURAL ELBOW ACTION DOES THE TRICK

. . . Eliminates the Hard Work of Clamping and Unclamping the Fixture



THE operation of manually clamping and unclamping fixtures requires considerable effort — usually much more than the mere handling of the work. At a high rate of production, operators become arm-weary, slow down, spoil work. All this is eliminated with automatic clamping and releasing—a natural for CINCINNATI Duplex Hydro-Broach Machines.

Here you see an example of this labor saving and cost reducing feature. In swiveling from one station to the other, the swivel table — exclusively a CINCINNATI Duplex Hydro-Broach development — operates the jointed arms attached to the fixtures, automatically clamping and unclamping them.

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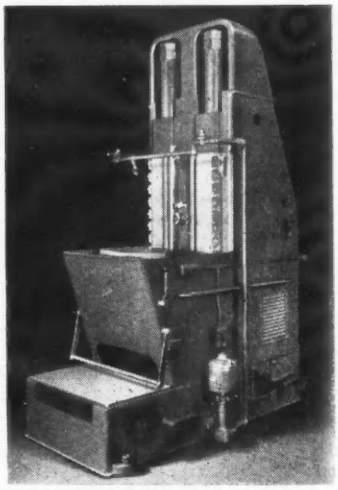
Of course, there are other CINCINNATI Hydro-Broach features of equal importance in high production of surface finished parts. Catalogs M-894 for the Duplex machines and M-886 for the Single Ram machines give you the whole story. Copies are yours for the asking.



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AUTOMOTIVE and AVIATION INDUSTRIES

Published on the 1st and 15th of the month

Vol. 88, No. 3
February 1, 1943

Military Engineering Problems Highlight SAE Annual Meeting

By P. M. Heldt

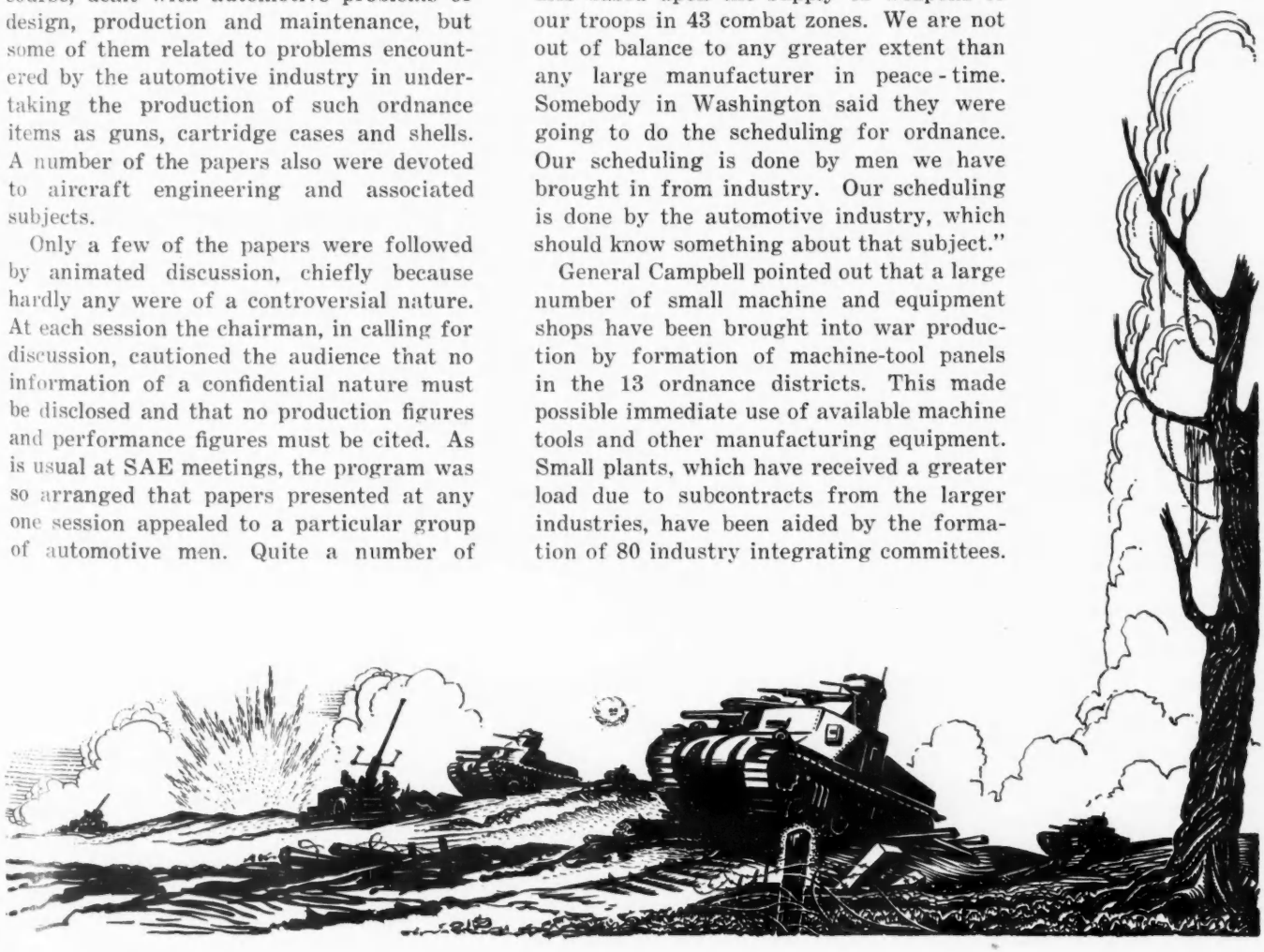
IN SPITE of the fact that the annual meeting of the Society of Automotive Engineers, January 11 to 15 at Detroit, was restricted almost entirely to military engineering, and recent advances in this branch of engineering cannot be discussed publicly, the meeting proved to be of unusual interest. Many of the papers presented embodied results of original research. The majority of the papers, of course, dealt with automotive problems of design, production and maintenance, but some of them related to problems encountered by the automotive industry in undertaking the production of such ordnance items as guns, cartridge cases and shells. A number of the papers also were devoted to aircraft engineering and associated subjects.

Only a few of the papers were followed by animated discussion, chiefly because hardly any were of a controversial nature. At each session the chairman, in calling for discussion, cautioned the audience that no information of a confidential nature must be disclosed and that no production figures and performance figures must be cited. As is usual at SAE meetings, the program was so arranged that papers presented at any one session appealed to a particular group of automotive men. Quite a number of high-ranking Army officers were present to discuss problems of military engineering and organization.

Ordnance Automotive Experience

"Ordnance is meeting its schedules, which are based upon the mobilization rate of our Army," said Maj.-Gen. Levin R. Campbell, Chief of Ordnance, in addressing the annual banquet. "Ordnance is meeting its schedules based upon the supply of weapons to our troops in 43 combat zones. We are not out of balance to any greater extent than any large manufacturer in peace-time. Somebody in Washington said they were going to do the scheduling for ordnance. Our scheduling is done by men we have brought in from industry. Our scheduling is done by the automotive industry, which should know something about that subject."

General Campbell pointed out that a large number of small machine and equipment shops have been brought into war production by formation of machine-tool panels in the 13 ordnance districts. This made possible immediate use of available machine tools and other manufacturing equipment. Small plants, which have received a greater load due to subcontracts from the larger industries, have been aided by the formation of 80 industry integrating committees.



These committees permit a group of manufacturers making the same ordnance item to form one large combine. This has tended to balance output and has kept many small independent manufacturers in business.

The small body of regular officers comprises only 2 per cent of the total officer strength of the Ordnance Dept., according to General Campbell. In addition to making ordnance officers of many engineers, production and maintenance men, scientists, statisticians and scheduling men, the department is maintaining a close affiliation with various technical and scientific bodies. The Ordnance Dept. works in close cooperation with the National Defense Research Council, the National Inventors Council, the Automotive Council for War Production, and other similar bodies. Gen. Campbell also listed as members of his personal staff three of the leading business executives of the country—K. T. Keller, president of Chrysler Corp.; Lewis H. Brown, of Johns-Manville, and Benjamin Fairless, of U. S. Steel Corp.

Gen. Campbell said the Ordnance Dept. now has four great divisions—research and development under Brig.-Gen. G. M. Barnes, which is charged with keeping our weapons superior to those of the enemy; industrial service under Maj.-Gen. T. J. Hayes, which has charge of all manufacturing activities, mainly through field offices; the field service under Brig.-Gen. H. R. Kutz, which provides for the supply and maintenance of all ordnance equipment with troops in the field, and military training, directed by Brig.-Gen. J. S. Hatcher, which operates the ordnance training schools.

Owing to the preponderance of the engineering, research and production work that is being carried on by civilian institutions, the title of the organization has been changed from the Ordnance-Industry to the Industry-Ordnance Department. The total output of Government arsenals is now less than 5 per cent of the ordnance requirements.

K. T. Keller was toastmaster at the banquet, which was attended by more than 1200 SAE members and guests. Mac Short, the newly-elected president of the SAE, took over that office from Col. A. W. Herrington, president of Marmon-Herrington Co., Inc.

Election of Officers

To assist President-elect Short with the 1943 program, the new vice presidents elected at the business session are: Aircraft—John G. Lee, assistant director of research, United Aircraft Corp.; Aircraft Engines—S. K. Hoffman, chief engineer, Lycoming Division of Aviation Corp.; Diesel Engines—Grover C. Wilson, fuel research engineer, Universal Oil Products Co., Chicago; Fuels and Lubricants—W. M. Holaday, automotive research engineer, Socony-Vacuum Oil Co.; Passenger Cars—R. E. Cole, vice president of engineering, Studebaker Corp.; Passenger Car-bodies—G. J. Monfort, Chrysler Corp.; Production—Arnold Lenz, assistant manufacturing manager, Chevrolet Motor Division of GM; Tractor & Industrial—C. G. Krieger, Ethyl Corp.; Transportation and Maintenance—Austin M. Wolf, automotive consultant, New York City; Truck & Bus—E. W. Allen, coach engineer, GM Truck & Coach Division of Yellow Truck & Coach Mfg. Co. David Beecroft, Bendix Aviation Corp., was re-elected treasurer.

Members elected to the SAE Council for 1943-44 were N. P. Peterson, president, Canadian Acme Screw & Gear, Ltd., Toronto; C. G. A. Rosen, director of research, Catapillar Tractor Co., and James C. Zeder, chief engineer, Chrysler Corp.

A dramatic touch was lent to the SAE Council meeting on January 10 by a broadcast of the "In Our Opinion" program over Station WJR in Detroit, featuring two outstanding representatives of the SAE, Arthur Nutt, vice-president in charge of engineering, Wright Aeronautical Corp., and D. G. Roos, vice-president and chief engineer, Willys-Overland Corp.

Following are abstracts of some of the papers presented at the technical sessions; abstracts of other papers will appear in forthcoming issues of AUTOMOTIVE AND AVIATION INDUSTRIES:

Two sessions of the meeting were sponsored by the Fuels and Lubricants Activity of the Society and papers read at these sessions will be reviewed in a later issue. There was a symposium on problems involved in cold starting of Diesel engines with no fewer than eight contributions. It is our intention to prepare a special article based on the information contained in these papers, for use in a later issue.

Abstracts of Some of the Interesting Papers

Materials for Bofors Gun

M. F. GARWOOD and E. H. Stilwill of Chrysler Corp. discussed the problem of the choice of materials for the Bofors anti-aircraft gun. The original specifications called for numerous alloy steels, but for most applications Chrysler selected only two such steels—the chrome-molybdenum steels 4340 and 4140.

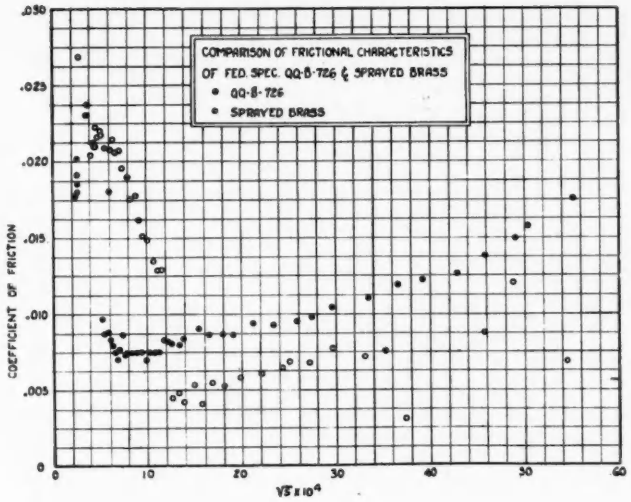
A survey of all alloy steel parts on the original gun disclosed that they could be roughly divided into two classes: A group being used at a hardness of about 45 Rockwell C, and another having somewhat lower requirements and being used at a hardness of approximately 26 Rockwell C. It was felt that prime consideration should be given to resistance to fatigue and wear. It further appeared that a majority of the working parts were stressed through their entire cross section. This observation, plus a consideration of production problems and available equipment, led to the choice of through-hardening steels for parts subjected to high stresses and severe wear. It was believed that SAE steel 4340 would readily meet all physical requirements, including those of hardenability and wear resistance, if it were heat-treated to 43/48 Rockwell C. The physical properties and hardenability characteristics of 4140 appeared sufficient for parts subjected to less stress and wear.

In response to a request to contribute to the tin-conservation program, nonferrous alloys were studied in a quest for one which would successfully replace the composition specified for various bushings and bearings, which contained 7.5 to 11 per cent tin. Copper-silicon alloys appeared promising. A number of cast silicon bronzes investigated were considered to have frictional characteristics equal to or better than those of the 90-10 bronze. Wearing characteristics in friction tests also were found favorable by comparison. In addition, the cast silicon bronze appeared to be less susceptible to seizure than the 90-10 alloy. It was therefore

recommended that a cast copper silicon be substituted for the tin-bearing alloy.

In an effort to conserve strategic metals, the possibility of metal spraying on certain gun parts was investigated. It was found that the shear strength of the bond in the direction of spraying was about 14,000 psi, while the strength at right angles to the direction of spraying was 16,700 psi. The hardness of the sprayed metal was 74/77 Brinell, using a 500-kg. load.

This analysis is considered only a fair bearing material, but in the sprayed form it showed up well in a test in which a flat slider with an area of ⅛ sq. in. was held against a steel disc that was being rotated at 1000 fpm, the contact surface being flooded with oil. At 5-minute intervals readings were taken of the load, the friction force, and the temperature at the face of the slider. After each reading the load was increased according to a definite schedule, up to a maximum of 6000 psi. The results of these tests are plotted in the accompanying chart—the friction coefficients as ordinates and values of the expression $10^4ZN/p$ as abscissas, where Z is the viscosity of the oil; N, the speed, and P, the unit bearing load. A study of the curves shows the friction characteristics of both bearing metals to be unstable in the region where the bearing conditions are most severe (2.5-12 on the scale of abseissas). The sprayed metal, however, appears to be comparable to the bronze chosen (Federal Specification ZZB-726). The sprayed brass seized at a load of 5440 psi and an oil temperature of 210 F. Examination of the bearings after regular seizure tests indicated that no alloying took place between the sprayed brass and steel. The bond appeared to be mechanical, the sprayed metal appearing as interlocked scales formed by flattening of tiny metallic particles. Calculations based on bond-shear tests indicated that the bond was at least as strong as the sprayed metal itself.

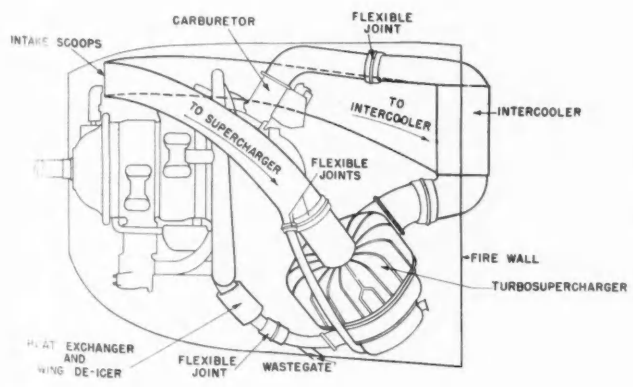


Comparison of the frictional characteristics of Fed. Spec. QQ-B-727 bearing bronze and sprayed brass

Integral-Power Plants

DR. SANFORD A. MOSS proposed an "integral-power plant plan" by which an aviation power plant would be built to form the front section of a nacelle, designed, assembled and tested by groups specializing on the particular job. These power-plant specialists would arrange the assembly of the engines, turbo-superchargers, generators, propellers and all accessories to get a certain over-all performance — one of the factors on which plane performance depends. Other groups of aerodynamic specialists would simultaneously prepare the plane up to the nacelle fire wall, and provide the studs or fastenings to which the integral power plant section would be attached. Standardization might make it possible to mount any integral power plant of given specifications to any plane, and one might even hope for a British-American standard, so that an American integral power plant would fit a British plane, and vice versa.

Dr. Moss, who has been intimately associated with turbosupercharger development, said he hoped the entire turbosupercharger addition would become part of the integral power plant. This would include the turbosupercharger itself, the flexible joint connecting it with the exhaust manifold, the ducts with ramming intake supplying cooling air to the turbosupercharger and the air cooler, the supercharged air ducts from the turbosupercharger to the air cooler and from the air cooler to the engine intake manifold, the air cooler and the exhaust ducts. The drawing reproduced herewith is a rough sketch of an integral power plant including turbosupercharger as it might be laid out.



Diagrammatic sketch of proposed integral power plant with turbosupercharger

The plan of making aircraft engines of the different types interchangeable did not meet with a very favorable reception on the part of the aeronautical engineers. It was pointed out that the liquid-cooled engine has the advantage of compactness in the transverse plan, and a resulting low drag, and that this advantage would be lost if the fire wall had to be made of sufficient size to accommodate a radial engine of equal output. Likewise, the single-row radial has the advantage of a low overhung moment, and this advantage would be lost if the engine supporting members had to be made strong enough to safely support a two-row engine of equal output.

Carburetion for Aircraft Engines

RECENTLY there has been considerable interest in checking the fuel/air ratio of the combustible mixture delivered to the engine in flight, according to F. J. Wiegand of Wright Aeronautical Corp., who presented a paper on Carburetion for the Aircraft Engine. Even though much development work has been done during the past five years on propeller governors, ignition systems, fuel systems, cowling, superchargers and instruments, many troubles blamed on the carburetor are traceable to erratic performance of the foregoing equipment.

The amount of air consumed by an engine is directly proportional to the indicated horse power. With mixture ratios close to the maximum-power proportion, the air consumption is about 5.9 lb. per ihp-hr. On the brake horse power basis the consumption varies between 6.6 and 7.4 lb. per bhp-hr, due to variations in the mechanical efficiency. The carburetor must meter the fuel in direct proportion to the mass-rate of air consumption, which is directly proportional to the indicated hp.

The engine, however, cannot operate on a maximum-power mixture throughout its range, and the fuel/air ratio should vary with the air-flow rate as

(*Turn to page* 36, *please*)

The Stewart-Warner Corp. fuse assembly line.

Automotive Parts Makers in W

CONVERSION of the major vehicle manufacturers to war production has been a leading topic of discussion during the past two years, but so far little has been said or written about the war activities of the parts makers. It is the object of this paper to record the accomplishments of this branch of the industry in the war effort.

It may be safely said that automotive parts makers are as close to 100 per cent on war production as any industrial group can be. By the very nature of their business, some must continue to cater to the service needs of the public, private transportation, etc., and the proportion of their effort devoted directly to supplying the needs of the military services may range as low as 80 per cent. The great majority, however, contribute from 95 to 100 per cent to the war effort.

It was evident from the start that the war effort would be best served if the various plants continued to turn out products of the same general character. For instance, producers of engines, engine valves, crankshafts, pistons, piston rings, electrical equipment, carburetors, etc., could serve best by continuing the same specialties. An adjustment in the viewpoint had to be made, however. With the stoppage of passenger-car production, the energies of a given organization had to be directed to serving military airplane requirements, building engines for the Navy and parts for tanks, tractors and amphibian vehicles, etc. Production was shifted to larger versions of the usual product, to heavy-duty models. Numerically the outputs required were lower than when parts for up to five million passenger cars had to be produced per year, and in some cases this caused a shift from mass-production as the term is understood in the automotive industry, to job-lot production. This increased unit costs materially, and the dollar volume is many times greater than normally.

This article is an abstract of the paper presented by Mr. Geschelin Jan. 12 at the SAE Annual Meeting in Detroit.

Classification of the

1. Producers of heavy-duty axles, clutches, and transmissions, for motor trucks, buses, tractors, etc.
2. Producers of axles, clutches, and transmissions for passenger car use.
3. Commercial-engine builders for trucks, tractor, bus, marine and industrial use.
4. Body builders.
5. Spring makers (for engine springs, chassis springs, etc.)
6. Producers of pistons, piston rings, cylinder liners.
7. Manufacturers of engine valves and valve lifters.
8. Manufacturers of electrical equipment.
9. Producers of the variety of accessories used on passenger cars, trucks and buses—lamps, signaling devices, windshield wipers, visors, cigar lighters, mirrors, etc.

This is the Seventy-eighth in the series of monthly production features

Producers of other types of accessories for the automotive industry found themselves without a market for even a limited volume of service parts. This group set about to convert radically for the production of war items completely outside their past experience. Even here, however, the conversion was engineered to take advantage of the "know-how" of the organization, of its equipment and facilities. Thus we find major body builders engaged in making parts for large airplanes —wings, tail surfaces, engine nacelles, fuselage sections, etc. Others have undertaken the making of guns and gun mounts, fuses, cartridge cases, and the like. Some are making bomb sights, gyroscopes and gyro-compasses, machine tools and propellers.

War Work

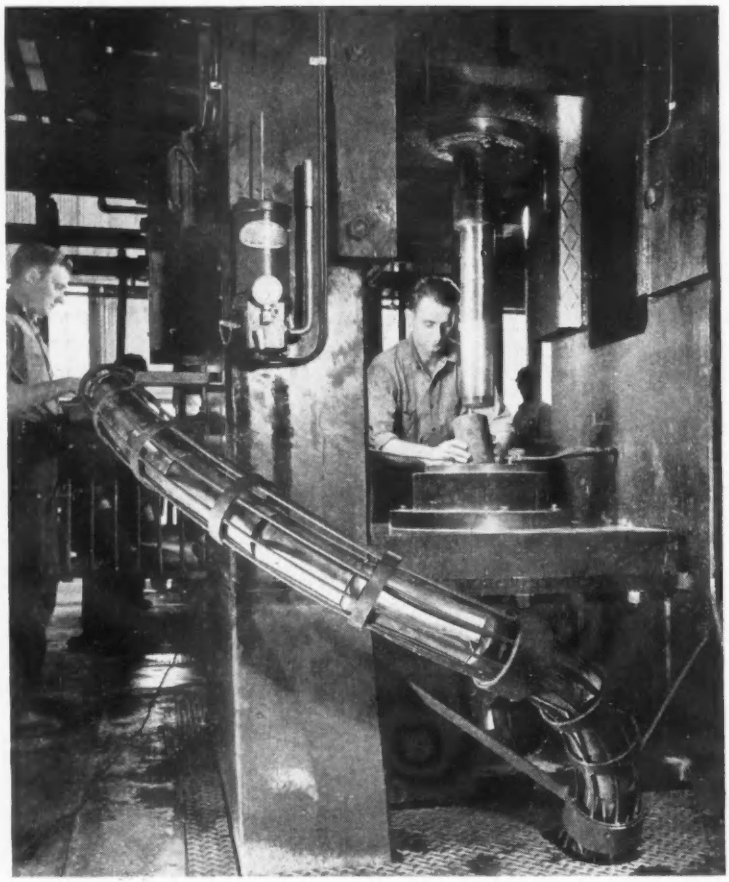
By Joseph Geschelin

Parts Manufacturers

10. Manufacturers of brake systems.
11. Carburetor specialists.
12. Drop forging, stamping, die casting, plastic molding, and a host of other specialties.
13. Specialists making radiators and heaters.
14. Producers of trim items, hardware, moldings, upholstery, etc.
15. Bearing manufacturers.
16. Wheel and brake drum manufacturers.
17. Radio manufacturers.

(Above) Feeding steel cartridge cases into the tapering machine at Auto Lite's Corcoran-Brown plant in Cincinnati.

(Below) Firewalls for Flying Fortresses in production at the Murray Body Corp.



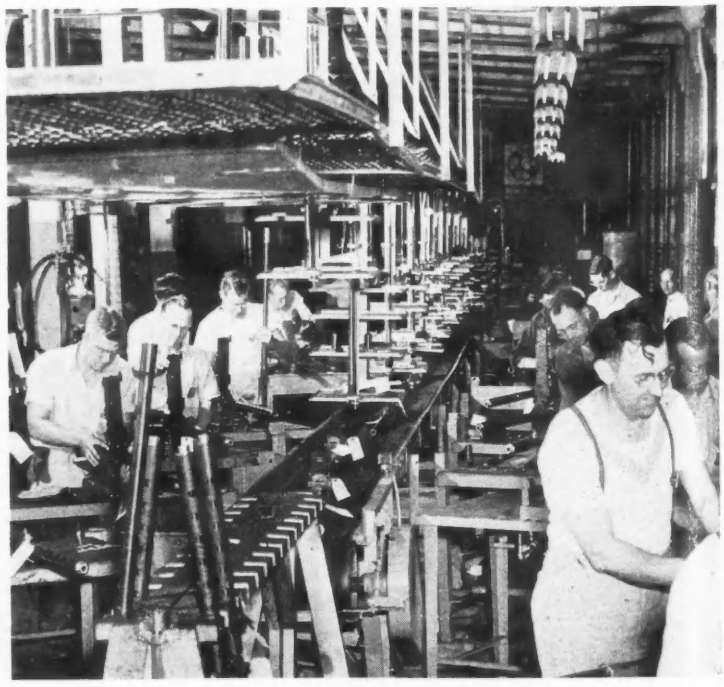
Now producing shell cases at one of its plants, Borg-Warner Corp. adapted this machine so that the plunger not only shapes the shell casing blank, but also pushes the blank down through the die underneath the machine and then out through the carrier and on up to another operation. It is believed to double the capacity of the machine.

A better background for a study of the industry's war efforts is obtained by considering the activities of its various technical and trade organizations, such as the Automotive Council for War Production, the Society of Automotive Engineers, the Automotive Parts and Equipment Manufacturers Association, the National Standard Parts Association, the Motor and Equipment Manufacturers Association, and the National Automotive Parts Association. These organizations, each representing a specific cross section of the industry's activity, have made a remarkable contribution to the war effort.

From the many examples of conversion and industry cooperation, let us consider just a few selected at random. Owing to both space and time limitations we can make only a tiny sampling of the whole. Let us consider first some representative axle and transmission builders.

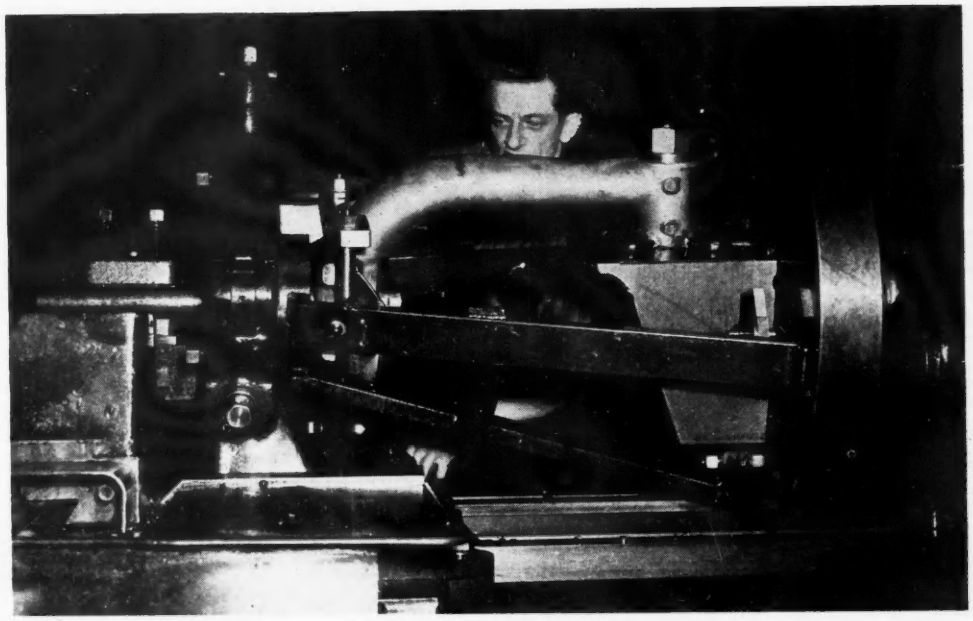
The Timken-Detroit Axle Company is proud of its record of cooperation with the U. S. Army on problems of motorization and mechanization since World War I. Cooperation was extended by it through direct consultation with all services of the U. S. Army concerned with motor vehicles, and by serving on advisory committees such as the SAE-Quartermaster and the SAE-Ordnance groups. As a result of this intimate contact with the U. S. Army, Timken was tooled up and had available front driving axles, rear driving axles, tandem rear-axle units, transfer cases, gun-carriage axles, and final-drive units for tanks, for sale to prime contractors. Timken contributed to the development of drive elements for military vehicles and combat tanks not only in the design phases, but also by building pilot models for the Army's proving grounds.

Spicer Mfg. Co. has followed a similar course. For many years this organization worked with Holabird Ordnance Motor Base on motor transport vehicles, and with the Army Ordnance Department in Washington and at Rock Island Arsenal on combat vehicles. Spicer's war activities, which started about two years ago, embrace the production of propeller shafts and universal joints, front and rear axles, transmissions, transfer cases, clutches and power take-offs. These war products are of the same general character as Spicer's normal production, and although there were differences in size, quantity, and details of design, it was possible to utilize all of the existing equipment. The change-over was made



A section of the machine gun assembly line at the AC Spark Plug plant. The automotive conveyor technique was introduced in the manufacture of this non-automotive product.

(Right) Among the war products of the Houde Engineering Division of the Houdaille-Hershey Corp., manufacturers of self-contained items for the automotive industry, are large half-forks for airplane landing gears. They are processed from solid forgings which are first bored out through their entire length, bent into the form as shown in the photo, and then turned in the fixture.



(Below) Looms formerly used to weave asbestos tape for brake lining by the Thermoid Co. have been converted to weave tape for safety belts for the U. S. Army Air Force. At the left, the threads are being woven into the belts which can be seen winding up on the drums at the right.

by a reorganization of plant layout and by the acquisition of many items of new equipment. In addition, Spicer has completed a major plant expansion program designed to provide facilities for the mass production of light tank transmissions.

In similar fashion, we find that the other major producers in the field of heavy-duty drive elements, such as Eaton Axle Co. and Clark Equipment, have made a major contribution to the Army's motorization program. Both of these companies have carried through a major expansion program to speed the output of essential units. Clark Equipment, for example, has built a new plant for the production of heavy-duty axles and axle housings.

Another example in a related field is that of the Twin Disc Clutch Co., producers of a variety of power-transmission devices for machine tools, for agricultural tractors, and for all forms of machinery using internal combustion engines. Conversion to war production in this instance was simply a matter of expansion and sub-contracting to handle the demand for a greatly increased output of essentially the same products. Some short time ago, Twin Disc developed a line of hydraulic transmission units which now will be built exclusively for military vehicles. To handle this program, the company has undertaken a major expansion program in its Rockford plant.

We may now consider briefly what has happened to manufacturers of automotive wheels and bodies. Kelsey-Hayes Wheel Co. is devoting practically 100 per cent of its facilities to war production. Among its current products are machine guns, projectiles, cylinder barrels for radial airplane engines, oxygen cylinders, wheel assemblies and other parts for tanks, airplane parts, armor plate castings, axle-housing castings, wheels, hubs, brakes and gun-carriage equipment. In the main, the war equipment produced by the company was so chosen as to make possible the utilization of facilities formerly used for automotive production. However, the greatly increased volume made it necessary to enlarge plant facilities materially. The company's foundry was converted to the production of steel castings and armor-plate castings.

Motor Wheel Corp., another of the leading names in the parts field, is now 100 per cent on war work, its products including projectiles, wheels, hubs, centrifuse brake drums and other stamped parts, bogie wheels and idler wheels for tanks. In addition, the company is doing a great amount of sub-contract work for builders of machine guns and cannon. One of its major

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By Robert Taylor
Supervisor of X-Ray and Inspection, Illinois Division,
Bendix Aviation Corp.*

THE non-destructive radiographic inspection of material specimens has for some time occupied the attention of engineers, metallurgists, physicists and radiographers. The impetus given to this method by the War Effort has brought closer to most of us its inestimable value as an inspection tool.

This type of inspection must meet the requirements of efficient organization. Haphazard methods are undesirable because they are unreliable and tend to make the radiographic department a "bottleneck." Repeating of inspection because of faulty techniques as a result of badly planned initial precedure should be discouraged.

The present application of radiographic inspection is extremely diversified and includes:

Class 1

High pressure vessels for distillation of gasoline and oils
Turbine engine construction
Armaments and protective plates
High pressure steam valves
High pressure pipe line welds
Steel shafting
Heavy machinery

Equipment required for the above class is supervoltage, over 250 K.V.P. and radium.

Class 2

Foundries—steel, iron
Structural and pressure welding
Welder testing
Foundries—aluminum and bronze
Brass mills
Shipbuilding
Railroad materials
Hot and cold wire drawing
Bronze bearing manufacture
Ball bearing—rims and balls
Airplane engine parts

Automotive parts
Steel bar stock
Extruded metals
Field inspection—structural, pipes
Firearms
Cylinder blocks
High KW Radio transmitters
Copper rolling
Drop forgings
Small valves
Wire ropes
Tools and hardware
Pump manufacture

Equipment suitable for the above class of work would be 250 K.V.P. This covers most average plants for fabricating steel up to 3½ in. and bronze up to 2-¼ in.

Class 3

Foundries—Steel — iron — aluminum — magnesium — bronze, malleable iron, die-castings.
Aviation—Engine parts (no cylinder blocks) Castings—welds—engine supports—magnetos—sparkplugs.

Aluminum bars
Small bearings
Radio tubes
Rolled sheet stocks
Stainless steel welds
Electrical assemblies
Contactors
Sealed-in-devices
Heating elements
Detonator caps
Bakelite moulds
Wood products
Wood impregnation
Metal spinnings

Equipment to cover class 3 should be intermediate of 150 K.V.P.

Class 4

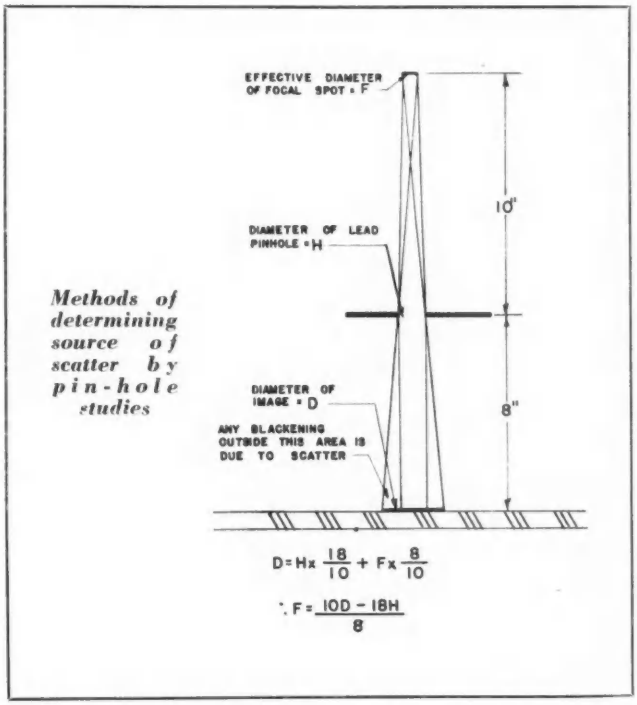
Spot welds
Fabrics
Insulation material
Fibre stock
Cristal splitting for radio
Research
Museums and art
Schools, physics laboratories

Equipment for class 4 should be low voltage 50 K.V.P. or less.

While this lengthy list might appear to include almost everything in creation actually it is only the beginning. One with imagination and a knowledge of the properties of X-radiation can readily see hundreds of additional applications.

When the question arises pertaining to radiographic inspection, one may review the fact that the Aeronautical Division of the U. S. Government requires radiographic examination of most parts of a plane, including riveting and welds. Specifications for aircraft engines likewise call for this type of inspection for certain parts. This type of inspection is required by the Bureau of Ships, U. S. Navy Department and, in fact specifications are becoming more stringent today to the extent that before a producer can market his product he must in many cases submit it to the radiographic test.

X-ray or gamma-ray inspection is a non-destructive test or examination of the entire quantity of a lot. In other words X-ray enables us to examine every



Methods of determining source of scatter by pin-hole studies

* The statements made herein are those of the authors and do not necessarily reflect those of the Illinois Division, Bendix Aviation Corp.

Principles of

Industrial Radiography

casting or weldment of a lot without destroying one of them. Heretofore it was necessary to take one out of every 10 or 12 castings, cut it up and physically determine if there were any flaws. If there were none in that particular casting, it was assumed the other 9 or 11 were also perfect. Furthermore it meant that 8 to 10 per cent of the entire run was destroyed by physical examination. If a defective casting or forging was passed as satisfactory, it then went to the machine shop where many man-hours were spent on machining it. Then it passed on to final assembly which might be a part of a marine Diesel engine or an aircraft engine. The cost of replacing this single casting or forging might possibly run into thousands of dollars.

The problems of the industrial users of X-ray are many and varied. Cost is secondary if the savings effected are substantial. Its main purpose is to detect a fault at or as near as possible to its point of origin. Whereas one of its largest applications is in radiography of castings, in the high pressure field where operating pressures are going higher and higher, now up to 1200 psi and operating temperatures as high as 950 F., X-ray and gamma-ray play a most important part since now every pipe joint must be welded and every pressure vessel welded at all seams.

One of the earliest applications of radiography for industrial use was performed at Watertown Arsenal in 1923. These studies were published by the American Society for Testing Materials in 1923 and attracted considerable interest in the industrial world. The Navy's active interest in this type of inspection began in 1929. In 1930 radiographic inspection of welds was first used by the Bureau of Engineering, U. S. Navy. Specifications for boiler drums required this inspection for all longitudinal and circumferential joints. This led to the formal adoption of this requirement for all welded pressure vessels, both fired and unfired for high pressure service. Application of radiography to steel castings was first adopted at the Norfolk Navy Yard in November, 1930.

Table 1—Relative X-ray absorbing power of various metals

Element	Atomic No.	Absorption Coefficient at 0.631 A.U.
Magnesium	12	3.00
Aluminum	13	3.75
Chromium	24	22.00
Manganese	25	25.00 (?)
Iron	26	27.50
Copper	29	37.20
Tungsten	74	75.00

Table 2—Penetrameter inserts for various thicknesses of steel

Steel Thickness	Size of hole in Penetrameter At Film	At Object
1.50 in.	0.015 in.	0.03 in.
1.75 in.	.02 in.	.035 in.
2.00 in.	.025 in.	.04 in.

Navy inspectors may require radiography of the following locations among others, for investigating development of defects indicated by pressure tests or for other reasons:

Main and intermediate shaft struts
Rudder castings
Rudder skegs
Rudder posts
Sternposts
Main stem line valves and fittings
Boiler stop valves and others
Skegs
Stern tubes
Turret roller posts
Turret holding down clips
Turret buffer castings
Superheater fittings

In 1931 the A.S.M.E. Boiler Code made radiographic examination of welded seams mandatory for power boiler drums and other pressure vessels designed for severe service conditions. Other code requirements soon followed. For weldments in penstocks installed in recent dams built by the U. S. Government, the specifications required radiographic examination.

The above application of X-rays and gamma rays to industry required much research and study to determine proper techniques applicable to the various conditions. Atomic numbers of various metals together with their absorption coefficients had to be thoroughly understood before anything but haphazard methods could be employed (see Table 1). Application of penetrameters properly chosen for the type of examination being made were necessary as a check on technical methods in use (see Table 2).

The detection of a small defect in a specimen depends on the behavior of the X-rays or gamma rays in passing through the metal, the properties of the film and intensfying screens and the ability of the eye to

(*Turn to page 56, please*)

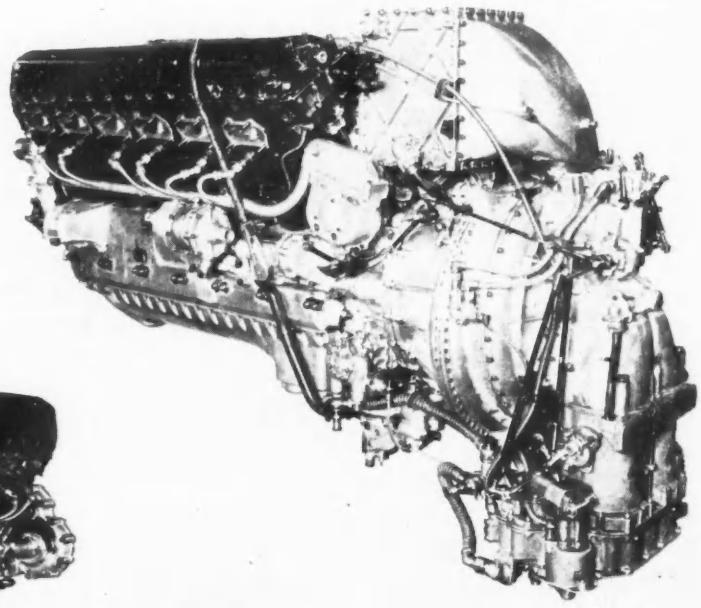
British Combine

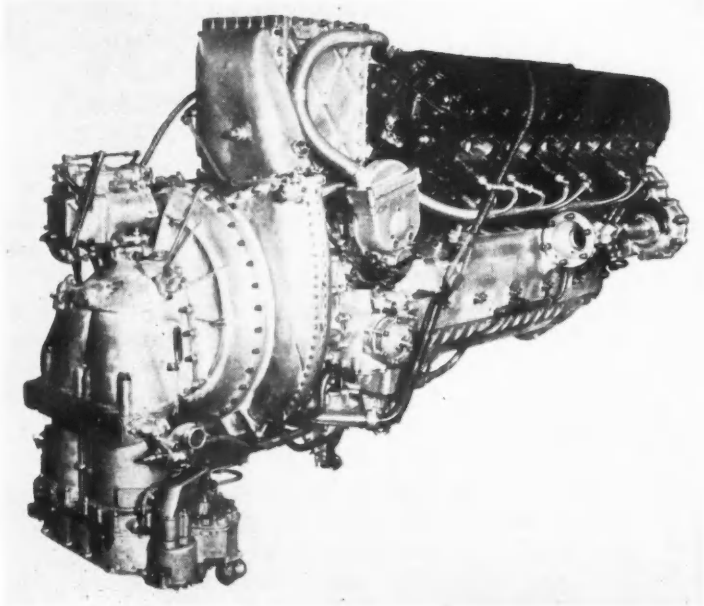
New Rolls-Royce Engine

and the Stratosphere Plane It Powers

Top of page—Powered by the Merlin 61 engine, the improved British Spitfire fighter has a service ceiling in excess of 40,000 ft. Other changes include a Rotol four-bladed propeller and two radiators mounted under the wings. Faired stubs next to the cannon permit the installation of two more cannon if required. An extra fuel tank can be installed behind the air intake.

Below—The main duct from the second stage of the supercharger to the intercooler can be seen in this view of the Rolls-Royce Merlin 61, which was described in the January 15 issue of Automotive and Aviation Industries.





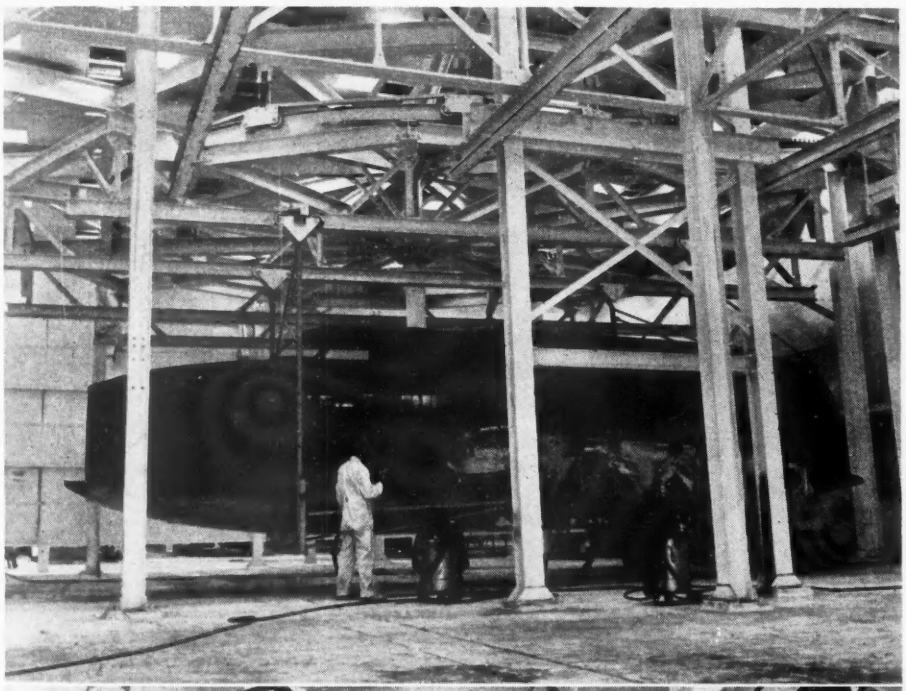
Above—In this rear view of the new Rolls-Royce Merlin 61 engine are shown the two-speed, two-stage supercharger, the twin-choke S.U. carburetor, and behind the cylinder blocks the rectangular casing of the inter-cooler installed between the supercharger and intake manifold. Otherwise its design is similar to the Merlin XX. The only other important change in design being a two-piece cylinder like the Packard Merlin XX construction.

Overhead Rotary Conveyors

In Douglas Paint Booths

WHEN the large paint booths were developed for the B-17 bomber assembly lines at the Douglas aircraft plant, an overhead rotary conveyor system was incorporated in them so that it would not be necessary to do any painting on the assembly lines themselves. Each of the four main assembly lines is served by a separate paint booth with a transfer trolley between the assembly line and booth conveyor rails. On the fuselage line a unique transfer arrangement outside the booth makes it possible to move the fuselage assembly to one of three prepared positions before entering the continuing overhead assembly conveyor.

Painting in the booths includes the Air Corps insignia and the complete camouflage of parts. No additional touch-up is done on the assembly line as all painting in the building must be completed within the booths. Paint fumes are removed from them by 16 powerful exhaust fans which change the air at the rate of twice a minute, making it unnecessary to install vapor proof electrical connections or other protective devices for the workers. The vapor is washed through water screens before being exhausted. Each booth is 100 ft by 50 ft by 23 ft high.



(Top) In the paint booth the fuselage section is suspended from the overhead rotary conveyor, which makes it possible to place it in the most advantageous positions for spraying.

(Left) The booth conveyor has just been moved after the fuselage was rolled onto it from the fixed trolley. The conveyor is rotated by a drive chain.

Fatigue of Metals

By J. O. Almen
General Motors Research

FULLY 90 per cent of all fatigue failures occurring in service or during laboratory and road tests are traceable to design and production defects, and only the remaining 10 per cent are primarily the responsibility of the metallurgist as defects in material, material specification, or heat treatment. While this ratio is not a measure of the quality of workmanship contributed by each department, there can be no doubt that the metallurgist has a better appreciation of his responsibility for fatigue failures than has the designer, the engineer, or the man in the production department.

The development of engineering materials, designs and processes requires that we conduct laboratory tests by which these factors may be evaluated, but to devise a reliable laboratory test is far from simple. The common belief that we can reproduce the conditions of service in a laboratory test is wholly erroneous. By the time the laboratory investigator has provided for all of the conditions that occur in service, he will, in the case of automobile parts, find himself on the road with a complete automobile, and even then he will not represent the type of driver who most severely taxes the strength of the machine. Many laboratory tests have been used (and are still being used) by which to grade materials and processes that are now known to have been very costly to the automobile and other industries. Thus, the fiction that a carburized part should have a hard case to resist wear and a tough core to resist breakage arose from laboratory impact tests. In this test the strength of the part was judged by the number or intensity of hammer blows a part would withstand before fracture, and since, for example, gear teeth resisted impact fracture in accordance with the physical properties of the core, it seemed logical to specify heat treatments to bring out the best compromise between the imagined requirements of the case and the core. Being compromises, these heat treatments were not the best for either region. If, instead of counting the number or measuring the intensity of hammer blows to produce fracture, the testing engineer had examined the gear tooth after the first impact, he would have found it bent, and therefore ruined. Hence, it would make no difference how many more blows were required to fracture the tooth. This compromise heat treatment resulted in reducing the quality of many millions of gears before it was realized that gear teeth fail by fatigue, and that fatigue failure, for the usual depth of carburization, always originates at the surface of the case. It then became clear that the heat treatment should consider the requirements of the carburized case only, and that the properties of the core were relatively unimportant since, in bending and in torsion, the core serves mainly as a stuffing for the case.

Alloy Steels

Similarly, gear steels and steels for many other parts have long been selected by false standards that are based only upon arbitrary laboratory tests, among which are fatigue tests of ideal specimens. For many years, industry has paid premium prices for alloy steels because of their fancied advantages when used in gears and in other parts. Fatigue tests on actual machine parts correlated with service records have shown that there is no detectable difference between the high-priced alloy steels and many of the low-priced alloy steels when used in many machine elements. This is probably due to the fact that, as fatigue specimens, machine parts are so far removed from the ideal laboratory fatigue specimens that the latter are misleading as measures of worth. In all probability there are real differences in the fatigue characteristics of the various alloys, but these differences are, in many cases, so small in comparison with the mechanical fatigue hazards introduced by the design and fabrication of the machine part as to be negligible.

Surface Finishes

Efforts to improve products by improving surface finish sometimes may have the opposite effect. Highly-finished surfaces and fillets may lead to a false sense of security if, as the result of machining or straightening operations, the parts have high internal stresses of the wrong kind. In ground surfaces, such as shafts, wrist pins, and gear teeth, the grinding operation may introduce high surface tension stresses, and thus promote fatigue failures. It is the writer's opinion that, from the standpoint of fatigue strength, more harm than good often results from the grinding of machine parts. The surface tension stresses from grinding often are so great as to produce visible or magnaflux surface cracks but, whether detectable or not, surface tension is frequently very serious.

Internal stresses of the wrong kind are perhaps the most insidious of all fatigue hazards, because we seldom can know their magnitude or the pattern in which they are distributed within the material, or whether they are alike for all commercially-identical machine

Excerpts from paper presented before the American Society for Metals—Detroit Chapter.

S as influenced by design and internal stresses

parts. Internal stresses may be the result of operating conditions, such as occur in brake drums, clutch plates or other friction surfaces, where the instantaneous temperature in a thin layer is so great that, under thermal expansion, the surface layer is stressed beyond the yield point in compression. When the source of heat is removed, the heated surface layer is quenched by the adjacent cool metal and, under thermal contraction, it is so severely stressed in tension that fractures often occur. The same thing, of course, happens in grinding, unless great care is used.

Magnitude of Surface-Tension Stress

The magnitude of surface-tension stress in a specimen that was ground in accordance with normal commercial practice is shown in Fig. 1. A specimen of annealed spring stock 1/16 in. thick, 1 in. wide and 7 in. long was ground to a depth of 0.002 in. After grinding the previously-straight specimen was found to be concave on the ground side, indicating tension stress. Very thin layers were then removed from the ground surface by hand honing, until the specimen regained its initial straightness. Measurements of the change in curvature with each thin layer removed permitted calculation of the stress distribution as shown in the chart. Obviously, a stress of 270,000 psi—just below the fracture point of full hard steel—could not be supported by the steel in the annealed state, from which it follows that the stressed layer was hardened by the heat cycle of the grinding operation to not less than Rockwell 55 C.

Residual Stresses from Processing

Internal stresses often result from the cooling of castings and forgings, or from the vigorous heat transfer of heat treating. Many parts, such as crankshafts, axle shafts, and camshafts, require straightening during processing. Since the straightening operation usually is carried out at room temperature, and since the part is rarely stress-relieved after straightening, the result is severe internal stresses. In turning, milling and other machining operations, it is necessary that metal be removed at a minimum cost, and, therefore, the cutting tools often must take deep cuts at high feed rates. Since metal cutting is more accurately described as a metal-tearing operation, so far as stresses are concerned, we need not be surprised to find serious internal stresses to considerable depths after machining. When metal cutting has been unusually severe, or after operations such as punching and shearing, we often find that the surfaces are actually fractured. Finish machining or grinding rarely goes deep enough to remove the internally-stressed metal from previous rough machining, and, of course, these finishing operations add stresses of their own.

Whenever it is economically practicable, internal stresses that produce tension in any surface layer subjected to cyclic tension stress should be reduced or removed or—better still—converted to compressive stress by suitable treatment, because all fatigue failures are due to tension stresses.

The surfaces of repeatedly stressed specimens, no matter how perfectly they are finished, are much more vulnerable to fatigue than the deeper layers. It has long been appreciated that the vulnerability to fatigue increases as the surface roughness is increased, particularly if the roughness consists of sharp notches, and more particularly if the notches are oriented at right angles to the principal stress. The practice of carefully finishing fatigue test specimens is, of course,

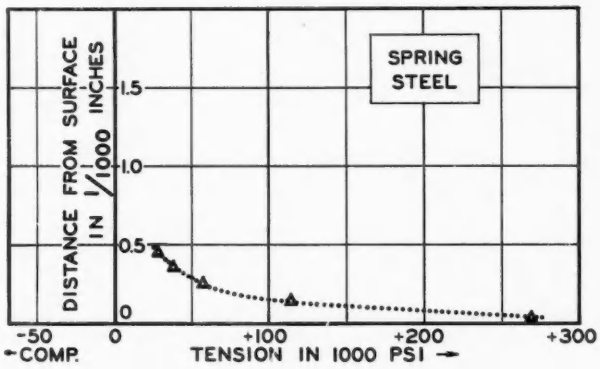


Fig. 1—Residual stress caused by grinding

a recognition of this vulnerability insofar as visible marks or scratches are concerned, even down to assuring that the final polishing marks are parallel to the direction of the applied stress. These precautions are known to be effective in increasing the fatigue strength of the specimens, and specimens finished in this manner, therefore, have come to be known as "par" bars. This name implies that fatigue specimens approaching perfection in finish give the highest possible fatigue endurance for any particular material and that they accurately measure the ultimate fatigue properties of that material.

It can be shown, however, that the so-called "par" bars are not the best specimens and that influences akin to notches, so far as fatigue vulnerability is concerned, are retained by them. It seems that the specimen surface is highly vulnerable simply because it is a surface; that there is an extra hazard in the surface

layer not shared by the deeper layers. This extra surface hazard may be due to sub-microscopic notch effects, or to the fact that the surface is a discontinuity, since the outer crystals are not supported on their outer faces. Whatever the reason for surface vulnerability, the evidence of its existence is strong.

Fatigue Life Increased

The fatigue strength of the most carefully prepared specimen will be increased if a thin surface layer of the specimen is pre-stressed in compression by a peening operation such as peen hammering, swaging, shot blasting or tumbling, or by pressure operations by balls or rollers. Tests show that the compression-stressed surface is effective whether applied to highly-finished specimens or to specimens having rough surfaces.

We are all familiar with the improvement in fatigue that may be obtained by a few cycles of overload in such parts as springs. Local stresses from the overloads exceed the elastic limit of the material, and, therefore, the tension stress at the working load is decreased. This treatment, which has long been applied to many production items, is the equivalent of rolling or peening, since, in the unloaded state, the member is stressed in compression in the areas where tension yield occurred during the overloading.

The most plausible explanation of the effectiveness of surface-compression stress is that when a load is applied to such specimens the tension stress in the surface layer is less by the amount of the compression pre-stress, and since fatigue failure starts only from tension stress, the fatigue durability of the surface layer is increased. However, the tension stress in the material below the pre-stressed layer is not reduced, and actually may be increased, notwithstanding which the fatigue strength of the specimen is increased. It follows, therefore, that the lower layer is inherently stronger than the surface layer. Föppl has shown that the fracture in rolled specimens does not originate at the surface, but in the material below the pre-stressed layer, as would be expected if the surface is sufficiently pre-stressed in compression. Similar sub-surface fatigue failures, usually called fissures and attributed to faulty material, have long been known to occur in railroad rails, in which the surface is stressed in compression as a result of the cold work of heavily-loaded locomotive and car wheels.

While on the subject of beneficial internal stresses, mention should be made of surface compressive stress obtainable by heat treatment. By a rapid quench it is possible to trap compressive stress in the chilled surface and corresponding tension stress in the core, but this method, although showing some benefit in fatigue, is not so effective as the other methods that have been discussed.

Perhaps the most spectacular use of surface-compression stress by heat treatment is tempered glass which, because of its great strength, is used in some parts of modern automobiles. This glass is prepared from normal glass by rapidly cooling the surfaces by means of air jets. The cooled surfaces contract, causing the relatively plastic center to yield in compression. As the center of the glass cools and contracts, it becomes stressed in tension, with consequent compressive stress in the surfaces.

Cold working of metals increases the hardness of most metals, including steel, at least in the range of low hardness. It usually results in internal stresses of varying degrees and patterns; it alters the physical properties, and it sometimes fractures the material. With the known sensitivity of materials to fatigue, it is obvious that we must learn how to control cold work just as we have had to learn how to control heat treatment in order that we may benefit by the good effects and overcome the evil effects. We would not think of specifying a heat treatment without stating whether the temperature should be raised or lowered and in which order and to what extent, yet that is the way we now think of cold work. Cold working can be good or bad, depending upon how it is done and for what purpose.

Papers have been published showing that cold working of the surface so as to produce a layer stressed in compression increases the fatigue strength of the parts to which it is applied, but we are not told the amount of the pre-stress or the depth of the pre-stressed layer. Both of these values presumably are important in obtaining optimum results for any particular specimen, but it is probable that the values should not be the same for all sizes of specimens, for all materials, or for hard and soft specimens.

When the compression-stressed layer is produced by applying sufficient pressure on the work by means of rollers, or by peening, to exceed the yield strength of the metal, the amount of pre-stress presumably is not less than the yield strength of the material. The depth of the stressed layer probably is roughly proportional to the instantaneous area over which the pressure is applied, as well as to the pressure intensity. The depth of the compression-stressed layer in a railroad rail should be greater than the depth of the compression-stressed layer in the same material produced by small rollers at the same pressure intensity, and when fatigued, the initial point of fracture should appear at corresponding depths. Such evidence as is available indicates this to be true. The magnitude of the sub-sur-

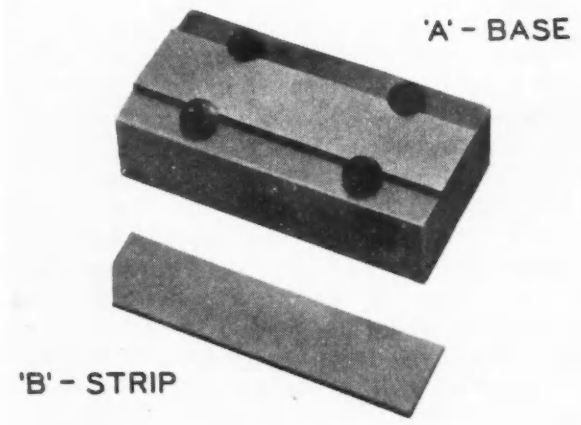


Fig. 2—Apparatus for measuring compression stressed layer

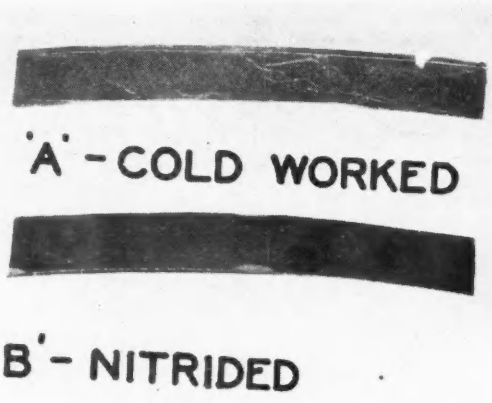


Fig. 3—Measuring strips

face tension stress in a loaded beam having compression pre-stressed surfaces will vary with the amount of compression pre-stress and with the depth of the pre-stressed layer.

A simple and practical method of measuring the compression-stressed layer involves the use of a thin, flat strip, Fig. 2A, attached to a heavy base, as shown in Fig. 2-B. This strip is rolled or peened with an intensity giving the same pre-compression as in the machine part, and when it is removed from the base it will be found to be curved as in Fig. 3-A, with the convex surface on the cold-worked side. The curvature of the strip may be measured by an indicator, and can then be interpreted in terms of the depth of the stressed layer.

When carburized parts such as bearing races, wrist pins, and gear teeth are ground we may expect the surface to be stressed in tension.

The internal compressive stress in the carburized layer may be a hazard for members stressed in tension, because the tension stress in the core is equal to the working load plus the tension load due to the compressive pre-load of the case. For members stressed in bending and in torsion, the internal compressive stress in the carburized case improves the fatigue strength of the part, except for the thin surface layer which, especially after grinding, is severely stressed in tension. It is, however, a simple matter to convert this thin tension-stressed layer into a compression-stressed one, by suitable peening or rolling operations.

Bolt Failures

The fatigue vulnerability of bolts and studs has been discussed in many papers, and the improvements resulting from reducing the diameter of the bolt body and from pressure rolling of the threads have been adequately recorded. Insufficient attention, however, has been given to the vulnerability due to insufficient bolt tightness. A bolt or stud should be tightened to a load exceeding the maximum working load. When properly tightened against rigid members, a bolt or stud cannot fatigue, because there can be no change in stress, and the bolt load therefore is static, even though the load applied to the bolted member oscillates at high frequency between zero and the maximum. This rule, however, must be applied with caution, because all bolted members are elastic in some degree, and the design of the bolted members may be such that the applied load is greater than can possibly be supported by the bolt.

An exaggerated case of this kind is shown in Fig. 4-A, in which the bolts are excessively stressed in tension and in bending, because the distance from the bolt to point C is small, and as the bolted parts tend to bend about point C as a fulcrum, the tension and bending loads in the bolts are great. Fig. 4-B illustrates an improved design in which the fulcrum point C is farther removed from the bolt and, therefore, the tension and bending loads are reduced. This is a case in which fatigue failure of one member is due to faulty design of another member. Such cases are frequently encountered in practice.

If the bolt in Fig. 4-B should fail by fatigue, the failure still could not be charged to insufficient bolt strength, because, as stated above, if the initial bolt tension is less than the applied load, the stress range under repeated loads is increased. Let us suppose that the bolt is tightened just enough to bring the surfaces into contact without appreciable tension. Under alternating stress the stress range would be from zero to maximum, and fatigue failure could be avoided only by greatly increasing the bolt strength. As the initial bolt tension is increased, the stress range is decreased until it approaches zero when the initial bolt tension is equal to or greater than the maximum working load. This illustrates a case in which a bolt fatigue failure is not the fault of either bolt strength or of design, but is chargeable to bad assembly practice.

The vulnerability to fatigue as a function of bolt tightness is shown in Fig. 5. In these tests all bolts were subjected to a cyclic tension load of 9210 lb., but were tightened to initial tensions of 1420, 5920, 7220 and 8420 lb. Fifteen bolts in each of the three lower groups of the graph, were tested in order to partially establish the scatter band for this kind of specimens. Only two bolts were tested in which the initial tension was 8420 lb., one of these failed after 4,650,000 stress cycles, while the second had not failed after ten million stress cycles. These are not shown on the graph because to do so would have necessitated compressing the stress scale to undesirable propor-

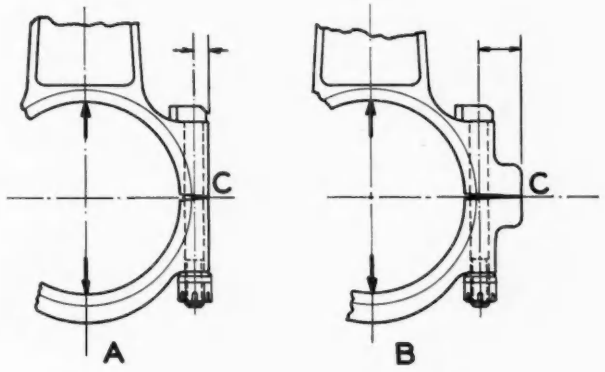


Fig. 4—Connecting rod design

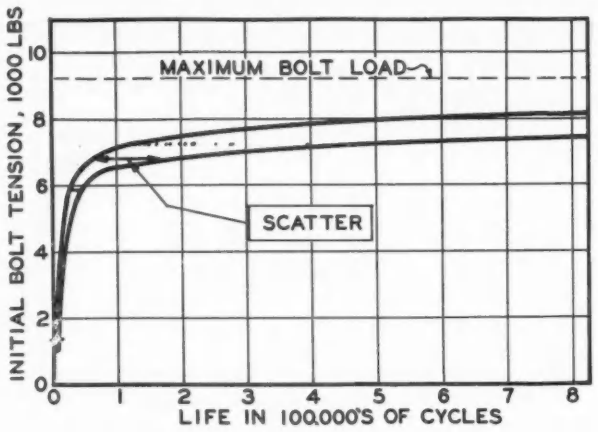


Fig. 5—Effect of tightness on bolt life

tions. The bolts used in these tests were of ⅜-in. diameter and were accurately dimensioned and finished. The threads were of U. S. form, twenty-four threads per inch, and were ground to close limits.

Stress Range in Bolts

The stress range to which these bolts were subjected is the difference between the initial load and the maximum operating load, and since it is known that the fatigue durability is increased as the stress range is decreased, we would expect results of the order that were obtained from these tests, as shown in the chart. All failures occured in the threads, except in a few cases where the threads were rolled to pre-stress the roots of the threads in compression.

In these rolled-threaded bolts the fatigue durability of the threads was increased sufficiently to cause failure in the bolt shanks. When the surfaces of the bolt shanks were also compression pre-stressed by peening, the failures were again transferred to the threads but, of course the durability was increased. These tests, therefore, also show that the fatigue durability of cut-and-ground screw threads can be increased by rolling, and indicate that compression pre-stressing of the surface of pure tension members is effective in increasing their fatigue strength.

It is evident that the fatigue strength of bolts and studs stressed in tension is dependent upon the initial tension applied by the nut, and upon the elasticity of the bolted members. Therefore, washers, lock washers, gaskets and other units that add to the elasticity of the bolted assembly are definite fatigue hazards, and should be avoided whenever possible. The initial tension applied by the nut is difficult to determine, unless the elongation of the bolt or stud can be measured. Measurement of the torque applied to the wrench is very unreliable, because of the variability of friction. Fig. 6 records tension measurements plotted against wrench torque in lb-ft. for 5/16-in. bolts having 24 threads per inch. It will be seen that the bolt tension varied as much as ten to one for constant wrench torque, depending upon the lubricant that was used. The "mechanical efficiency" of this bolt varied from one per cent to ten per cent, as shown in the chart.

Pre-loading of cyclically-stressed members to reduce the stress range, and thus to increase their fatigue durability, is not restricted to bolts, but may be applied to many machine parts. For example, the stress range in leaf-spring eyes can be reduced by pressing a bushing tightly into the spring eye.

A common cause of fatigue vulnerability is due to the belief—apparently held by many designers and engineers—that our structural materials are rigid. Many fatigue failures can be traced to elastic deflection for which no allowance was made in the design. Elastic deformation of mating parts may be such as to concentrate the load in a small region, as occurred under the conditions described for the bolt in Fig. 4-A.

Under operating conditions a crankshaft may be so elastically-deformed in twisting and in bending that the bearings are only partially effective in supporting the load. The bearings frequently are found to be plastically deformed or worn "bell mouthed" by elastic gyrations of the crankshaft.

Perhaps the most-generally misunderstood of all machine elements are the several classifications of gears. As ordinarily designed, there is only one thing certain about gears, and that is that they will not function as intended by the designer. When a set of gears is laid out on the *drafting board, the mating gear teeth are* represented by parallel straight lines, but no matter how carefully the gears are cut and heat treated, the mating teeth will never again be parallel except by accident, and then only through a small load range.

The nature of the contact between two mating gear teeth is influenced (a) by the elastic characteristics of the housing in which they are contained, (b) by the elastic characteristics of bearings by which they are supported, (c) by the elastic characteristics of the shafts upon which they are mounted, (d) by the elastic characteristics of the gears themselves, (e) by the accumulated dimensional errors in all the supporting parts as well as the errors in the cutting of the gears, (f) by the necessary and accidental clearances in the supporting parts, and (g)—to give the metallurgist some of the responsibility—by the amount and nature of the warpage in heat treating.

The result of all this is that it is virtually impossible that the parallelism between mating teeth as

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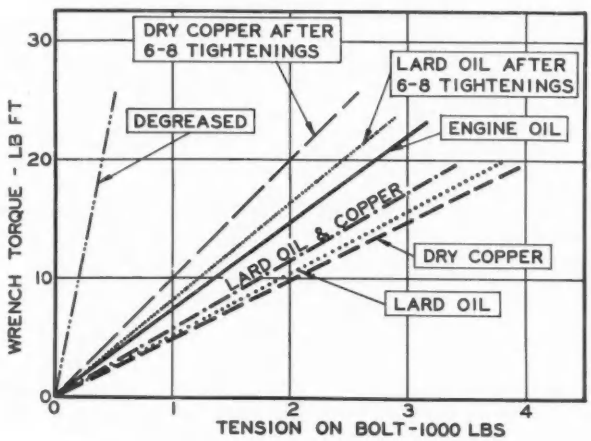
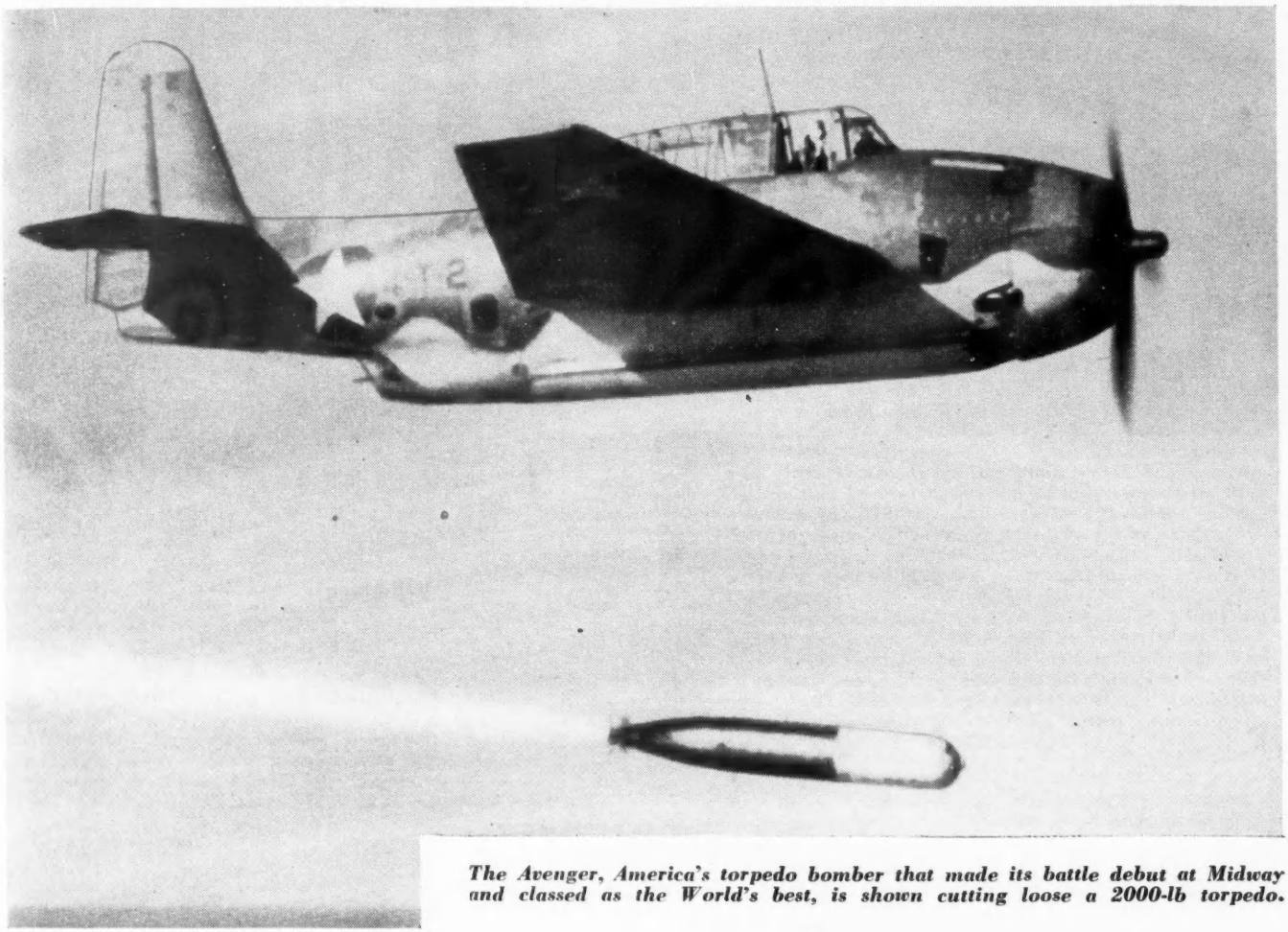


Fig. 6—Effect of lubricants on bolt tension

British Comment on U. S. Planes



The Avenger, America's torpedo bomber that made its battle debut at Midway and classed as the World's best, is shown cutting loose a 2000-lb torpedo.

As will be recalled, a recent report of the Office of War Information was devoted to setting forth the characteristics of American military airplanes. Our British friends were keenly interested in that report, particularly in view of the experience our allies have had with American planes.

One of our esteemed contemporaries, *The Aeroplane*, British aviation magazine, not long ago, published a summary of the report and later printed that part of its text which referred to characteristics of specific types, interpolating its own comments. These comments differed in some respects from those in the OWI report.

It should be kept in mind that, as E. T. Allen, Director of Flight and Aerodynamics of the Boeing Aircraft Co., in his Wilbur Wright Lecture pointed out: "The degree of accuracy attainable in measuring performance has been a highly controversial source of irritation to both commercial users of aircraft interested in economy and competitive performance and now, more especially, to the military services where such accuracy may day after day be a matter of life and death."

Although unfavorable in a few instances and favorable in others, these comments of *The Aeroplane* raised some points not considered heretofore. If past British appraisals are any indication, it can be said there is a sense of fairness throughout them for, when the occasion has warranted, enthusiastic praise has been given even to enemy developments. The comments of *The Aeroplane* follow:

Curtiss P-40—What is also needed in the P-40 is more speed. Even the Merlin motor cannot make this design the equal in performance of other better streamlined fighters and an armament of six 0.5-in. machine-guns hardly seems adequate today.

Bell P-39 (Airacobra) — Like the P-40, the Airacobra suffers from the low supercharge of its Allison Motor. The view forward is poor because of the steeply sloping windscreen. The tricycle nose wheel has given trouble on muddy aerodromes. Cockpit size is limited. Good low down.

North American P-51 (Mustang)—The Mustang looks like being the best American fighter yet produced. With the Allison it has a top speed of 370 mph and is excellent low down. It was designed to a specification laid down by the British and so has much active experience built into it.

Lockheed P-38 (Lightning)—Single-seaters are not suitable for long-range escort work. Top speed 360 mph. Reputed to be rather a handful for one man to fly.

Republic P-47 (Thunderbolt) — The great weight of the Tunderbolt—round 14,000 lb—makes it exceedingly heavy for a single-seat fighter.

Grumman F4F-4 (Wildcat) — The Wildcat—termed the Martlet by the Royal Navy—is an excellent machine and has done very well. Its top speed of 315 mph is good for a naval fighter, but will be far exceeded by the magnificent American Vought-Sikorsky Corsair 366 mph fighter now coming into service.

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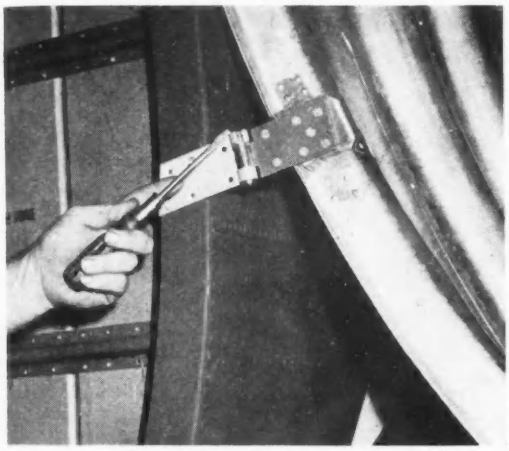
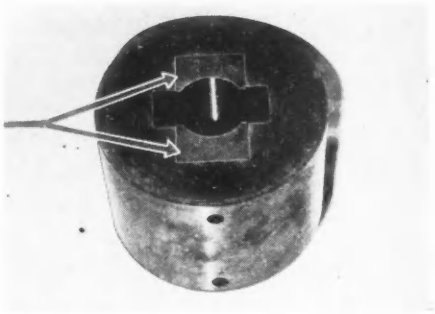
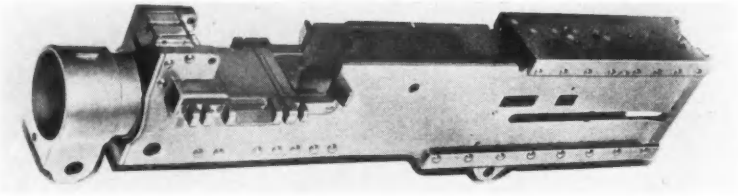
Short

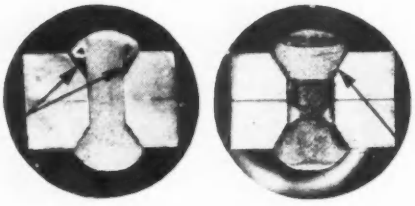


(Above) A new type hinge for Douglas C-47 cargo planes allows the door to be lifted off when in the open position, and thus expedites loading and unloading of bulky cargo. The complete operation of opening the cargo door and removing it takes one man 10 seconds now as compared with 15 minutes by two men before. This development did away with the hinge pin and certain difficult to procure forgings in favor of more easily acquired screw machine parts. It has a permanent flash welded fairing over the hinge, saves a dozen rivets, and $50 in time and material. Several operations have been excluded from the production line and the shop. Two hinges and one fairing have been eliminated along with the anchor chain tab, two feet of chain and two Dzus fasteners. This new type hinge is applicable to any aircraft door which needs to be removed and reset speedily.

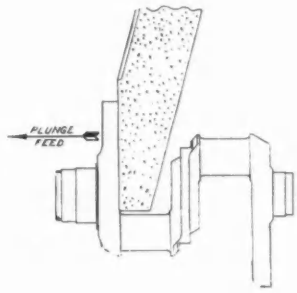


(Above) Boring bars used in deep-boring operations must be guided by guide bushings. Formerly these guide bushings were a one-piece construction and then required 75 lb. of tool steel. When the bushing was worn the entire part was scrapped. Delco Products Division of General Motors evolved this three-piece construction, with inserts adjusted to maintain the hole size. The body of the bushing never needs to be replaced.

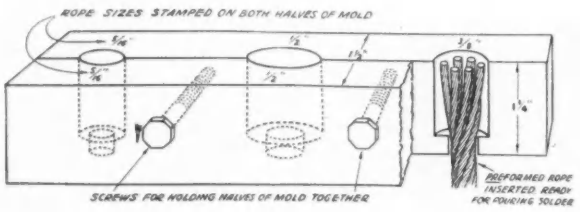




(Left and above) The top, bottom and side plates of the receiver of the Browning machine gun are riveted in place. Formerly the rivets were headed by hammering, but as shown by one of the enlarged photographic views, there was imperfect contact between the base metal and the rivet head, and the riveted joints loosened under vibration. At present, in the A.C. Spark Plug and Frigidaire Divisions of General Motors Corporation, the rivets are heated by electric current passed through them, and are then subjected to pressure, which causes them to fill the hole completely.

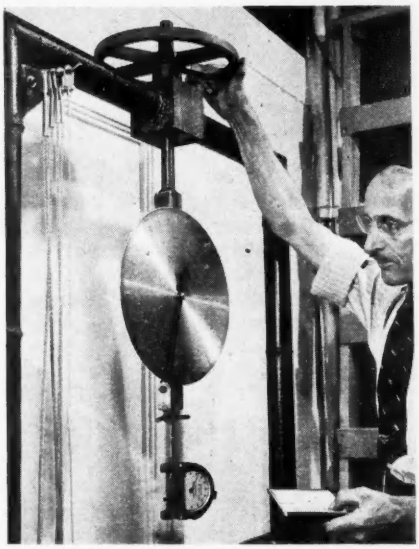


(Above) In grinding the sides of crankshaft cheeks, the practice has been to use a cylindrical grinding wheel which is gradually fed in from the outer part of the counterweight toward the crankpin. Chevrolet now uses an angular grinder, which makes line contact with the crankshaft arm. With this method there is less chance of the ground surface being tapered; because of the line contact the finish is better, and grinder life is increased. By the new method production is from 200 to 300 per cent of what it was with the old one.



(Left) Lugs of solder cast onto the ends of many of the wire ropes at the Kearney & Trecker factory have been found to be quite advantageous. For this purpose split molds are used similar to the one shown in the sketch. The end of the rope is tinned before it is inserted in the mold.

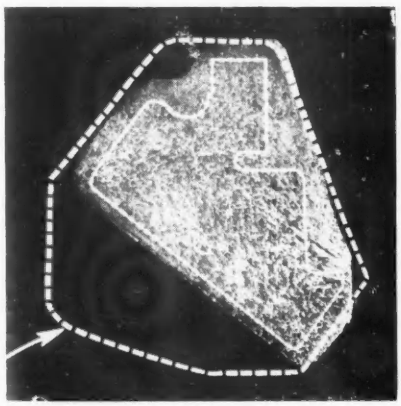
Cuts



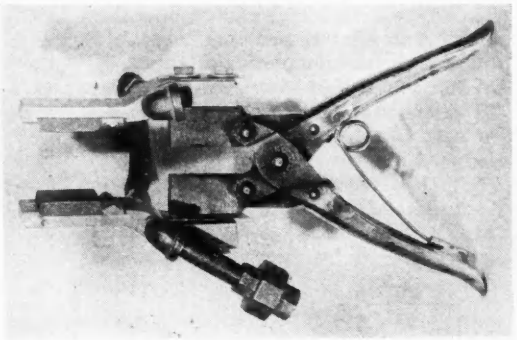
(Right) Vega engineers built this test apparatus for making a quick check of the accuracy of cable tension indicators. By applying tension at the rate of 10 pounds per reading, the indicator setting is checked against a conversion table and adjusted accordingly if necessary.

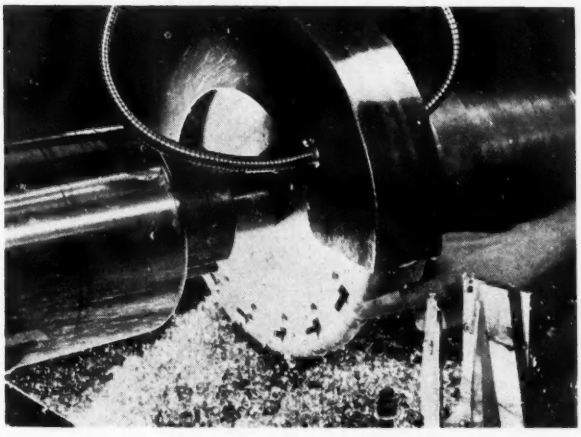
(Right) A new development at the Lockheed factory is this high-speed air driven router which trims off and trues up the skinned edges of the P-38 nose wheel well, in the bottom of the fuselage. Formerly, every door was a hand fitted job. This router, operating on tracks built into an insertion jig, now makes this opening uniform in every plane, and eliminates hand fitting of the doors, which used to require many man hours of work.

(Below) One of the new types of equipment developed at General Electric's Schenectady Works to meet production requirements with silver brazing is this pair of water-cooled tongs built up from a pair of 8-inch parallel flat nose pliers. Steel blocks are first welded onto the plier jaws to give them an outside width of 1½ in. when closed. These blocks are then drilled and tapped for ⅜-in. bolts. Bar copper of varying dimensions is bent to fit the clearances required for the particular job to be handled, and the tips are cut to hold small blocks of carbon. The bars are drilled and tapped to accommodate ¼-in. pipe fittings by means of which water-cooled power leads are attached. A rubber hose jumper forms a water connection between the jaws.



(Below) Bay-to-boom skin fittings for the Lockheed P-38 Interceptor are milled from 14-ST dural forgings by Carboloy cutters which make two 5½-in. cuts, each in five minutes. Fifteen Carboloy cutters are mounted in progression in a 14-in. circle, with an .005 in. feed and a speed of 381 rpm. Excessive vibration is a problem in this operation, but the Carboloy has been found to run six times as long without sharpening as other high-speed tool bits. A water-soluble oil is employed.



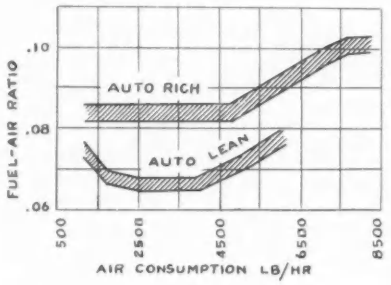


(Above) Propeller-shaft forgings for the Pratt & Whitney aircraft engine formerly were made in steam hammers from steel bars weighing 184 lb. They are now made by Buick in an upset forging machine and a steam hammer from bars weighing 165 lb., thereby saving 19 lb. of steel per shaft and reducing the machine-tool load. Similar savings in material and machine work have been made by changing the forging practice employed in connection with other parts. Thus the stationary gear of the propeller reduction gear formerly was forged in a steam hammer. Buick redesigned it so it could be made on a forging press, thereby saving 7 lb. of steel per shaft, reducing the machine-tool load and increasing production 300 per cent. In the illustration the outer white line indicates the size of the original forging, and the area between the metal section and the outer white line is indicative of the amount of steel saved. The generator drive-gear forging also was originally made in a steam hammer. When it also was redesigned and made in an upset forging machine, 1.1 lb. of steel was saved per gear and the machine-tool load reduced.

Abstracts of Some SAE Annual Meeting Papers

(*Continued from page* 19)

shown in the accompanying chart. Two mixture ranges are provided—rich and lean. The rich cruising mixture is required to ensure satisfactory cooling of the engine during flight at critical airplane altitudes (i.e., climb) at high



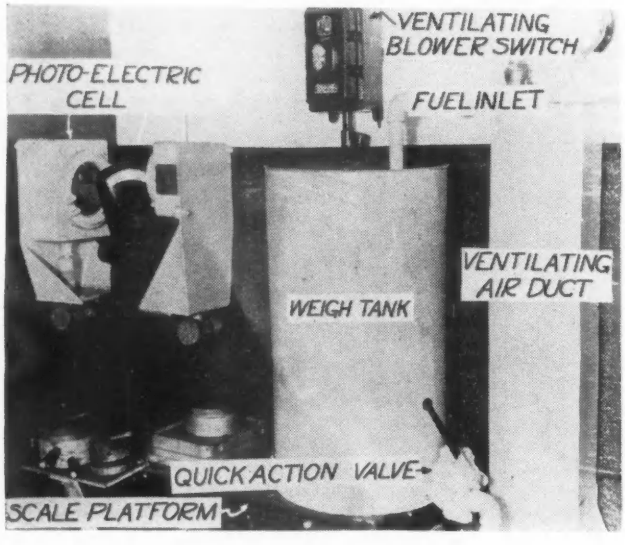
Fuel-air ratio versus air consumption

atmospheric temperatures. In the high-power range a rich mixture is required to avoid high cylinder temperatures and resulting detonation. The lean range is provided to insure fuel economy while cruising in level flight. The rich and lean mixture ranges are restricted by suitable tolerances, which in this case happen to be 2 per cent. These close tolerances are necessary to insure the utmost in performance, including both power output and economy, over the entire range. With the usual type of aircraft engine operating on a rich mixture during take-off in order to cool satisfactorily, there will be an appreciable change in the power if the mixture becomes too rich, and an appreciable change in the cylinder temperature if the mixture becomes too lean. Likewise, in the cruising range, deviations of more than 2 per cent from the standard ratio of the lean range can cause appreciable changes in the thermal efficiency of the engine, which in turn will affect the range of the plane. Excessive deviation from the mean or standard in the idle range results in "torching" or backfiring and poor acceleration—all of which are not considered permissible today. Experience in engine operation extending over the past five years has shown that carburetor metering must conform to the graph.

In the development of carburetors, apparatus for the measurement of rates of air flow and fuel flow plays an important part, and the author discussed such apparatus and its use at length. Air flow usually is measured by means of air bottles equipped with nozzles, varying in diameter from 1 in. to 7 in., and a suitably-calibrated draft gage. However, in order to insure a fair degree of accuracy, the rate of flow through the nozzle must be held within a limited range. With a 1200-hp engine the rate of air flow varies substantially between 100 and 8000 lb. per hour, and to make tolerably accurate measurements throughout this range it would be necessary to change the nozzle seven times. If this is done the air flow can be measured with an accuracy of 1.5 per cent.

There is a variety of equipment available for measuring rates of fuel flow, some types of apparatus measuring the mass rate of flow and others the volume rate of flow. Since the mass rate of flow is what is wanted, the equipment most suitable for the purpose consists of a weighing tank placed on a scale, with a timer actuated by a photo-electric cell which in turn is actuated by movement of the indicator hand of the scale. This type of equipment is used to calibrate rotometers, and is considered to weigh a volume of fuel within 0.5 per cent, regardless of fuel specific gravity or viscosity. However, since this equipment is rather bulky, a rotometer is often used, in spite of its lower accuracy. A standard rotometer consists of a tapered tube with a float, the pressure drop past this float being maintained constant over the range of flow for which the instrument is designed. As the volume rate of flow increases, the float rises.

The foregoing abstract covers only a small portion of the paper, which dealt with all phases of aircraft carburetor development and was favorably commented on by experts specializing in this field.



Equipment set-up for measuring mass rate of fuel flow in testing aircraft engine

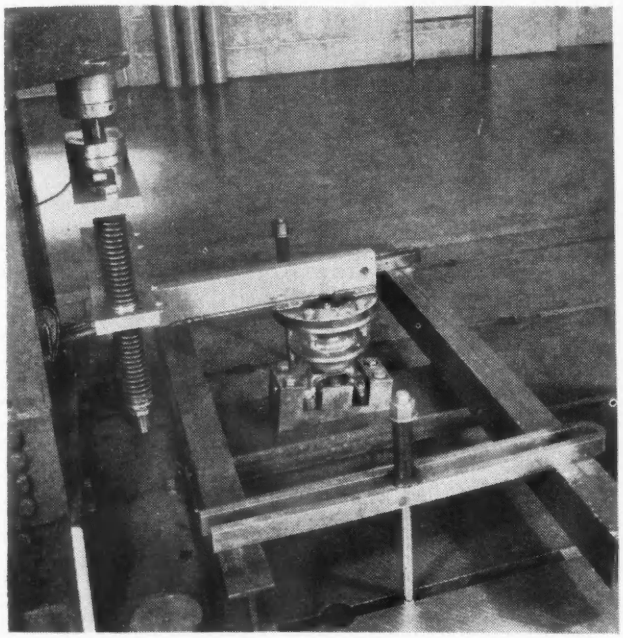
Substitute Materials

CONSIDERABLE light was shed on the problems confronting manufacturers as a result of the scarcity of certain materials, in a paper by John G. Wood and R. F. Sanders of the Chevrolet engineering staff. They said socalled critical materials may be divided into different groups. One group includes rubber, tin, chromium, tungsten, hemp, cork and India mica. These have become critical because their principal sources of supply are in enemy hands, or the shipping lanes between these sources and the U.S.A. are enemy controlled. Another group includes brass, bronze, copper alloys, zinc, manganese, nickel, lead and aluminum. These have become critical because of a shortage of labor in mining, considering the exceedingly large demand for the materials. The principal sources are in our possession, and it is our problem to produce the materials in large-enough quantities to meet the demand of the War Production Program, and to conserve as much as possible where their use is not essential.

A third group became critical in spite of the source being in our possession and the supply of labor ample. This group includes the synthetic-rubber and thermoplastic materials. The bottle neck in this group is manufacturing facilities, which were not provided for soon enough. The loss of our pricipal source of rubber supply to the enemy placed a heavy demand on this group of materials.

The steel group is critical for various reasons. Since this is a mechanical war, the demand for steel products is enormous, and steel production cannot be readily expanded. To increase the output of steel products requires not only more steel for the added production material, but also more steel for added furnaces, machinery, equipment, tooling and transportation.

In making a substitution for a critical alloy steel in a "safety item," such as a steering knuckle, an accelerated

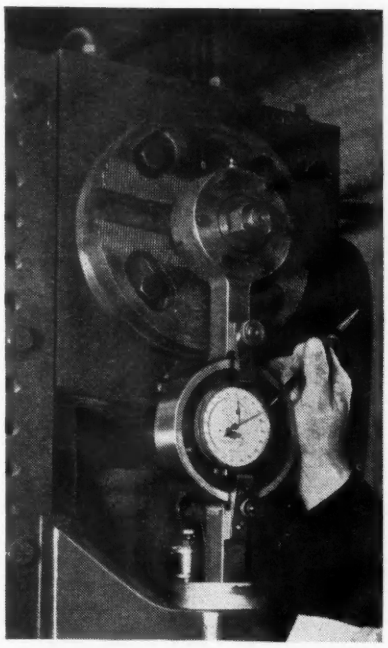


Steering knuckle with wheel hub in the "stroking machine"

laboratory test is now applied, known as the stroking test. If the results of the test on a particular substitute are as good as, or better than, those obtained with the production material, then it is safe to use it in production. The test set-up for the steering knuckle is shown by the photograph. The steering knuckle is mounted on an anchor block securely fastened to the floor bed plate, with the steering spindle pointing upward. A pin is driven through the king-pin hole and aligning holes drilled in the anchor block, and cap screws are placed in the knuckle-apron mounting holes to prevent it from tipping on the pin. A 1½-ton-truck front-wheel hub with bearings is installed on the spindle. A loading arm of 15.92 in. effective length is bolted at one end of the hub at the wheel-bolt holes, while the other end is connected to a spring saddle secured to the piston of the stroking machine. The second photograph shows how the applied load is measured by the deflection of a ring built into the piston rod. The gage is calibrated in pounds load.

Various trial stroking loads were applied in preliminary tests on stock steering knuckles. In these tests the load was decreased successively until failure was produced with a minimum of 100,000 cycles at 260 cycles per min. In each cycle the load was applied to the steering arm first downward and then upward. From these checks a load of 783 lb. (representing a front-wheel load of 1305 lb. with a friction coefficient of 0.6) was selected. Several samples of each type of steel were stroked till failure occurred, to obtain low, high, and average values of fatigue life. Steering knuckles of the original X3140 steel showed a minimum fatigue life of 128,000, a maximum of 241,000 and an average of 176,000 cycles. Therefore, 128,000 cycles to failure was taken as the minimum acceptable. The ratio of the high to the low fatigue life (1.88) was taken as an index of the non-uniformity of the material.

The first substitute material tested was C-4140, a molybdenum steel, which showed a minimum fatigue life of 188,870, an average of 261,290 and a non-uniformity ratio of 1.93. This was satisfactory, but the supply of this steel was found to be insufficient, so further tests had to be made. A steel known as MG≠1, Grainall-Treated, of which there apparently was a sufficient supply, showed a high/low radio of 5.77 and was therefore considered unsuitable, but by increasing the size of several fillets and various radii to reduce localization of stress, adding an increased fillet and a collar at the flange-plate pilot, and improving the machining at these points, an average fatigue life of 346,460 cycles and a high/low ratio of 1.87 were obtained.



Upper part of the stroking machine showin gthe flexible steel ring and gage used to measure the applied load

It was then found that the supply of MG≠1 steel could not be depended upon, and tests were made on NE 8744 steel. Although the average and high values obtained were better than with the original steel, the low value was below the minimum set (128,000). In an attempt to improve it, all areas subject to stress concentration were shot-blasted. This gave results far above those from any of the other materials tested (low fatigue life, 639,000 cycles; high, 1,636,980 cycles; average, 1,146,135; high/low ratio, 2.56), and it showed the great benefit derived from the shot-blasting operation.

Stress Determination In Engine Parts

THE old methods used to determine the stresses in engine parts and allowing for uncertainties by the introduction of factors of safety are no longer applicable in the design of aircraft and automobile engines, in which a high weight efficiency is essential, said Charles Lipson of Chrysler Corporation's Engineering Division. Accurate measurements of stress are needed, and Mr. Lipson's paper described the methods in use in the Chrysler Laboratory, and more particularly the application of stress-measuring methods in the development of engine parts.

The photoelastic method of stress determination is used extensively. A polarized beam of light thrown upon a transparent plastic model under mechanical stress, is split up into two components traveling in two principal planes. As a result of a difference in velocity of the two components, optical interference takes place, and the fringe number becomes an index of the acting stress. Mr. Lipson described the photoelastic apparatus in use in the Chrysler laboratory and its application to the determination of stresses and stress distribution in various engine parts.

Another method of stress determination involves the use of "Stresscoat." This is a brittle lacquer furnished by Magnaflux Corporation, which fractures at low values of tension strain (0.0005-0.001 in. per in.). It may be used as a coating on loaded parts to indicate the location, direction, and magnitude of tension strain. Compression strain also may be measured, by allowing the coating to come to a neutral condition while the part is under maximum load. A part to be tested by the Stresscoat method is first thoroughly cleaned, then sprayed with an aluminum undercoat to provide a reflecting surface which makes the stress pattern more easily visible. Stresscoat is then applied by means of an air brush in an even coating from 0.003 to 0.005 in. thickness. Calibration strips are sprayed at the same time and with the same lacquer as the part to be tested,

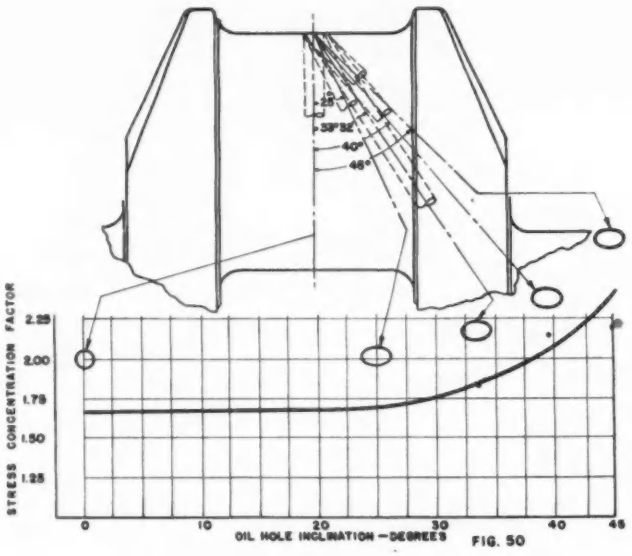


FIG. 50

Stress analysis of crankpin oil hole for various oil hole inclinations

and both are allowed to dry for at least six hours, and preferably over night. For calibration purposes, the strip is placed in a cantilever-beam fixture and subjected to a definite deflection by means of a cam. A moderate load is then applied to the test piece, the part is examined for stress cracks, and the load is removed. After a normalizing period equal to twice the period of the first load cycle, a load 20 per cent higher is applied, the piece is re-examined, and the process repeated.

Another instrument extensively used in stress determination is the extensometer. This is a device for accurately measuring changes in the distance between two fixed points on a part subjected to an external load. The original distance between the two points is known as the gage length, and this may be either several inches or a small fraction of an inch. Only extensometers of short gage length are used for stress determination, and means for the magnification of the strain are required. Mechanical, optical or electrical magnifying devices, or a combination of them, may be used. The author said there are six main types of extensometers in use today, known as the Huggenberger, Tuckerman, Tensor, Maze, photoelectric and electromagnetic. Brief descriptions and illustrations of these various strain gages were given in the paper.

There are three principal types of engine problems which can be studied by stress-analysis methods, viz., evolution of a new design, determination of causes of failure, and comparison between various designs. Examples of the three types of problems were given in the paper. One such problem is that of the effect of the inclination of the crankpin oil hole on the stress concentration. The test results (see drawing) showed that for a given crankshaft design there is no change in the crankpin stress for the range of oil-hole inclinations from 0 to 25 deg. From 25 to 45 deg. the stress increases, and with an oil hole at 45 deg. the stress is about 30 per cent greater than with a radial hole.

This abstract cannot do justice to the paper, which contained a mass of useful information on the application of stress-analysis methods in this particular field.

Positive-Displacement Blowers

AT THE final session of the meeting, on Friday afternoon, two new blowers or superchargers of the positive-displacement type were described in different papers. Both of these blowers are of similar type, each comprising two rotors with intermeshing helical teeth forming between them chambers which move the air in an axial or a diagonal direction. Both differ in operation from the well-known Roots blower in that the air is compressed within the blower chambers between closing of the inlet and opening of the delivery port, for which it is claimed that it increases the adiabatic efficiency. The two blowers presented, the Elliott-Lysholm and the Hamilton-Whitfield, differ, however, in the forms of their rotor teeth. An illustrated description of the Whitfield blower appeared in the Jan. 15 issue of A.A.I., hence we can confine ourselves here to an abstract of the paper on the Elliott-Lysholm blower, the authors of which were Alf Lysholm, chief engineer of Aktiebolaget Ljungstrom Angturbin, Stockholm; Ronald B. Smith, manager of research engineering, and W. A. Wilson, mechanical-division engineer, Development and Research Dept., Elliott Co., Jeannette, Pa.

This blower was developed in Sweden beginning in 1934. Air is transported diagonally by virtue of the pair of helically lobed rotors which interact to provide an axial as well as a cross seal. The distinguishing feature of the compressor lies in its action on each charge of suction air after it is sealed off from the inlet and before it is brought into communication with the discharge. A charge is initially enclosed in the space bounded by the tooth flanks, casing bore and end walls. The rotor helices are so chosen that a particular thread space is completely filled and sealed off from the suction just as it is entered at its opposite end by a coacting lobe on the other rotor. This results in approximately 240 deg. wrap of thread on the convex-lobed rotor and gives the largest discharge ports compatible with full utilization of the thread spaces. Further rotation establishes an axial seal which separates this charge from the charge in the succeeding grooves. As rotation proceeds, this seal moves axially, effecting a reduction in volume of the charge and a substantially adiabatic compression. When the leading lobes of the grooves pass the boundaries of the discharge port, the space filled with compressed air is brought into communication with the discharge. The location of the port thus determines the "built-in" compression ratio.

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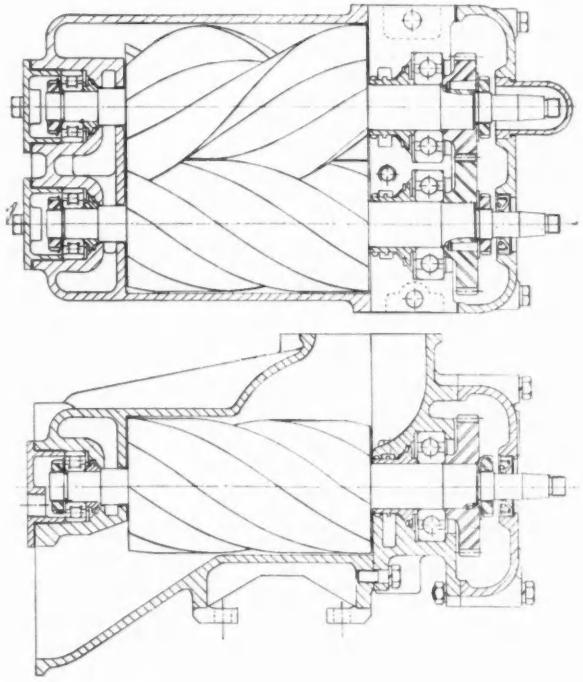


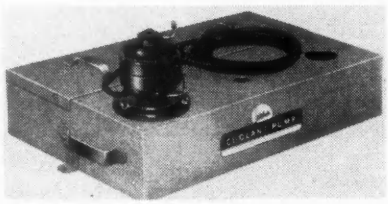
Lysholm compressor

New Production Equipment

Two new Foster Fastermatic Turret Lathes, No. 1-F and No. 2-F, are being offered by the International Machine Tool Corporation, Elkhart, Indiana. They are equipped with a flexible hydraulic feed system which provides an independent feed for each face of the turret. The hydraulic feeding mechanism is built into the machine, and the pump which operates the controls is mounted inside the bed, at the headstock. The coolant pump and the pump which operates the controls are driven from the main drive shaft. Oil pressure, adjustable from 300 to 1000 p.s.i., controls all feeding operations, and is provided by an Oilgear pump mounted in the bed below the headstock.

The motion of the hexagon turret slide provides the necessary feed to the front and rear cross slides by means of cams. The forward and reverse movement of the hexagon turret slide indexes the hexagon turret and cam roll.

Any group of automatic speeds within the specified range of these machines may be had by the proper set of pick-off gears. The 1-F Fastermatic has a range of 27 spindle speeds from 22 to 332 r.p.m., arranged in nine sets of three automatic changes. The 2-F Fastermatic has a range of 28 spindle speeds from 17 to 263 r.p.m., arranged in seven sets of four automatic changes. In operation, buttons engage ratchets which cause a valve to change to a different position with the forward movement of the hexagon turret, thus causing oil under pressure to shift a clutch in the headstock to make a speed change. Speed changes may be made at any time while the machine is in operation, during the cut or at the end of the turret stroke. A number of changes to a single turret face may be made as required. The number of changes made depends on the number of buttons placed on the spool, and the longitudinal position of the buttons determines when the spindle speed changes become effective.

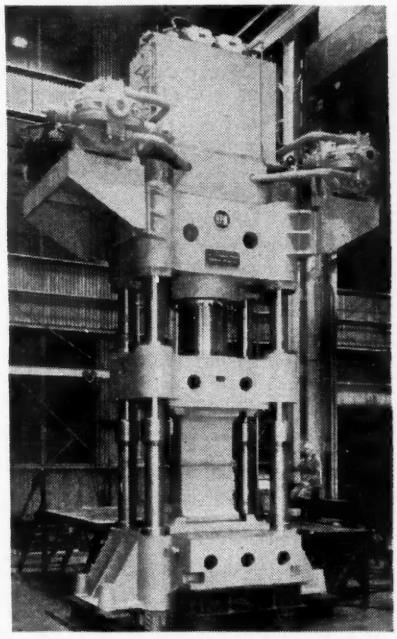


The Atlas No. W89 Universal Coolant Pump.

Two portable coolant pumps, adaptable to most machine tools, are announced by Atlas Press Company, Kalamazoo, Mich. Both models are equipped with centrifugal pumps which require no priming. The No. W89 coolant pump is equipped with a universal motor, and has a somewhat greater rate of delivery than the No. W88, which has an induction-type motor. Outlets for both pumps are ¼ in. pipe nipples, to which flexible feed lines may be attached.

A 1000-TON H-P-M Fastraverse, self-contained open forging press was completed recently by The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio. This press uses the Fastraverse principle of operation, which provides for prefilling and exhaust of the main cylinder during rapid traverse ram movement. Direct communication is afforded between the overhead oil tank and the main cylinder through the H-P-M Fastraverse valve, built into the cylinder head. This system assures complete prefilling of the press cylinder with oil, without cavitation, resulting in pressure build-up in a minimum of time.

The opening and closing rate of 560 inches per minute is metered by the H-P-M Hydro-Power radial hydraulic pump. The speed of the working stroke, after the die block contacts the billet, is 105 inches per minute. Ram travel is reversed by reversing the delivery of the radial pump, providing smooth, shockless reversal which is controlled manually by a remote hand lever.



1000-ton H-P-M FASTRAVERSE Open Forging Press.

Both the length and speed of ram travel are adjustable. Pressure builds up automatically as soon as resistance is met, which can be at any point within the limits of the ram travel. The amount of pressure applied to the work is controlled by the operator.

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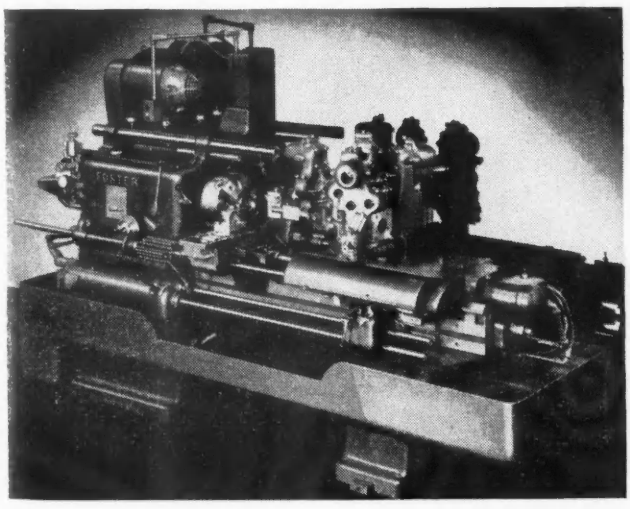


Fastermatic Turret Lathe.

Plastic

A clamping operation is necessary to control the shrinkage so that the material contracts from the top of the punch down as it cools.

The hot plastic is poured through a sheet metal lip of the cooking vessel directly to the Kirksite die, a funnel being used to avoid lapping of the material and air bubbles.

MORE consistent forming of sheet metal parts and more rapid production of such parts in the drop hammer or hydraulic press can now be acomplished through the use of a plastic punch. Tough, elastic, possessing great impact strength, this new thermoplastic is 100 per cent reclaimable without sacrifice of physical properties.

Early in 1942 the Vega Aircraft Corp., like many industries, was faced with the necessity of conserving critical metals. In an effort to find a desirable substitute for lead and Kirksite punches, a plastic product of the Plastalloy Co. of Burbank, Calif., was utilized. First trials were very promising, hence many further tests followed, formulations being constantly altered to meet the high impact required for such metal forming. Progress has been slow but decidedly encouraging. While some of the problems have not been entirely overcome, the method has reached such a degree of workability that results are here presented to the industry. It is hoped that others may profit by the research—and mistakes—that have been made.

A brief review of steps necessary in making and using a lead drop hammer punch will serve as a basis for judging the advantages of the plastic punch. Lead is cast to the Kirksite die without allowing for metal thickness of the part. Thus, the die must be set up in the hammer and the vertical surfaces scraped in to the die to allow for metal thickness. The drop hammer is obviously out of production during the operation. Further, it is often necessary to rescrape the punch after a number of parts have been formed because the soft lead punch tends to flatten and spread. Small radii on the punch are likewise beaten back, resulting in larger radii than obtained originally, so that rubber strips must be so placed in the die as to form the metal down to the small radii. Since this condition most frequently arises when as few as ten parts have been formed, production on the lot is appreciably slowed. An alternative is to run the whole lot through and then rehit the parts during a second run, using rubber. Either method involves a loss of time which is avoided when a plastic punch is used.

The plastic punch, like lead, is cast directly to the

Punches

for the forming of sheet metal parts

die, without clearance for metal thickness. Beyond this point, the simplicity and economy of the plastic punch method becomes apparent: 1. The punch and die are set up in the drop hammer; 2. Parts are then run.

It is unnecessary to scrape the punch into the die. Being elastic, it simply springs back to accommodate metal thickness of the part, recoil accounting for its excellent forming characteristics. The same qualities account for consistent forming of small radii, beads, and the like. It is unnecessary to use rubber strips to form beads. The useful life of a plastic punch has proved many times that of lead. In general, the plastic punch seems to possess the same characteristics as rubber under pressure and, when used in the drop hammer, combines the forming advantages of impact. It most consistently forms the part true to the die.

Other savings in production time and expense are illustrated by the following typical example of a lead and a plastic punch used at Vega.

Kirksite Die with Lead Punch

1. Hit approximately 100 parts one time.
2. Anneal.
3. Pour new punch.
4. Rehit 10 parts.
5. Rehit 90 parts using rubber strips to force out radii. (From three to six rehits may be required to produce a satisfactory part.)
6. Finished.

Kirksite Die with Plastic Punch

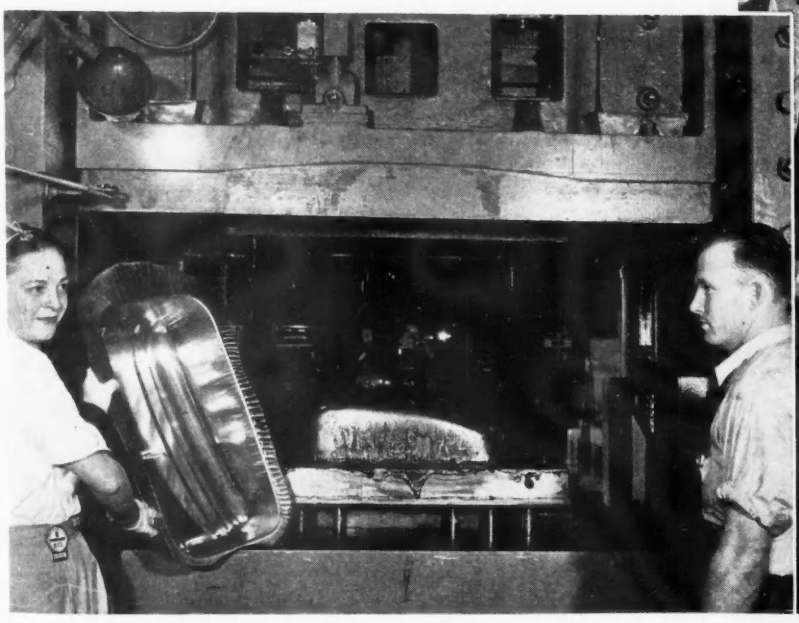
1. One fairly good blow to set.
2. Three blows in rapid succession.
3. Finished.

It is seen that by using a plastic punch an annealing operation and a rehit operation have been avoided. Foundry as well as drop hammer time is saved since it is unnecessary to pour a second punch.

This article was prepared from data compiled by Tool Research Engineering for the Vega Aircraft Corp. in collaboration with Leon Champer, chief chemist for the Plastalloy Co.

(Lower Right) Special full-scraper, spiral type agitator keeps the plastic mixed thoroughly and prevents burning during the six hours it is being cooked preparatory to being poured into the Kirksite die.

(Below) A part formed on the double action press using a plastic punch.



It should be understood that plastic punches, in their present stage of development, cannot be used on all types of jobs, but those parts which are most adapted to this method of forming may be determined readily. It has been found, for instance, that plastic punches, due to their rubber-like nature, do not iron out wrinkles as readily as lead or Kirksite. But, due to their close fit, fewer wrinkles occur in the first place. This type of punch is less successful, in many cases, in forming stainless steel parts. Often the same part, in aluminum, would form well.

Certain precautions are necessary when setting up the punch in the hammer in order to avoid subsequent cracking of the punch. Threaded inserts located in the punch should line up with holes in the head of the hammer. Otherwise when the stud bolts which are screwed into the inserts are forced into the hammer, strains are set up in the plastic which are considerably multiplied by impact of the punch in use. Hole locations in the Vega hammers are not uniformly located, but this difficulty has been overcome by using ⅞ in. studs in the 1-1/16 in. holes. One-inch studs are normally used in lead punches. Nuts used on these studs must be firmly tight only, not cinched up with tremendous pressure as when using a lead punch. Since most breakage of punches has been found traceable to cracks developing at the metal inserts, these precautions alone have served to reduce such troubles to a minimum. Results are more successful, also, if Plastalloy is warm (around 75° to 100 F.) when set up in the drop hammer. They should be observed even though the Plastalloy Co. has now developed a material that the drop hammers, in most instances, have not been able to break.

Hydraulic Press Punches

Success in the drop hammer field led to the development of Plastalloy punches for use in the double action hydraulic press. The long hours of tedious grinding required to fit the punch to the die and allow for metal thickness are avoided because, here again, the plastic punch is poured directly to the die. A limited amount of clearing of sides or shoulders is sometimes found necessary in order to secure better bottoming as, for example, when beads are to be formed in the bottom of a part. However, if this must be done it can be accomplished while the punch is in the press. In the case of the Kirksite punch and die they are pulled and later set up again for another trial. Thus the plastic punch saves press set up time. Generally speaking, the punch is merely poured directly to the die and set up in the press ready to go. Due to its elastic nature the punch forms the part true to the die. Normal production difficulties are obviously encountered, but they are solved as any manufacturing problem. For example, it was found difficult to form a number of parallel beads located in the bottom of a certain Vega part. Good beads were obtained by merely increasing pressure. In fact, it was found that enough pressure could be applied to tear the part around the bottom beads.

The following is a comparison of the two methods of making punches:

Kirksite Punch

1. Make templates
2. Make plaster pattern
3. Cast punch in sand, using mold taken from plaster.
4. Grind in punch to fit die, less metal thickness (time: 5 days)
5. Run parts
6. Anneal
7. Hit on drop hammer
8. Rout (trim)

Plastic Punch

1. Pour directly to die
2. Clear for metal thickness where necessary (time: 3½ hrs.)
3. Rout (trim)

Coating Plastic Punches

Ordinary wood sides are built up around the die and the inside wood surfaces are lined with tin. Fillets are made with molder's clay. Sides usually extend about 10 inches above top of die, resulting in a thicker punch than is usual in lead. Experience has shown that impact is better absorbed and transmitted when the plastic punch is about 25 per cent greater in thickness than would be a lead punch.

Two distinct Plastalloy materials are supplied and combined to form the final casting compound for punches. This is done to facilitate melting or preparation for casting. For convenience, these materials are termed Plastalloy "A" and Plastalloy "B." The former has a low melting point, while that of Plastalloy "B" is considerably higher. Plastalloy "A" is first melted to start a batch. When it has reached a liquid state, Plastalloy "B" is slowly added. The mixture is agitated from the start, and constantly during the "cook" to prevent its burning. Reclaimed pieces may be added while the mixture is being melted. As mentioned earlier in this article, Plastalloy is 100 per cent reclaimable. Used or broken punches may be broken up into chunks and remelted as indicated above. To attempt to remelt chunks directly often results in burning them before they have reached a state of fusion, hence remelt material should be added to a batch of new liquid.

The mixture is heated to and maintained about forty-five minutes at a temperature of 401 F, at which time the heating agent is cut off and the mix allowed to cool to 347 F, being agitated continuously.

While at this temperature the melt is cast into the Kirksite die, being poured through a special funnel (tin or similar material), the lower end of which is kept below the surface of Plastalloy in the die. Lapping of the material, which tends to cause weakened planes, and trapping of air is so avoided. Immediately after the punch is poured, the inserts, located by means of studs to a spider, are lowered into the punch to a predetermined depth. The top of the insert preferably should not lie more than one inch below the surface of the finished punch. Precautions that will insure normal and properly located inserts are: (1) level die; (2) spider parallel to die; (3) accurate spider; (4) holes for studs through spider to offer sliding fit yet hold studs close to 90 deg. Attention given these details will, in a large measure, reduce possibility of breaking punch in use.

The material is made to shrink from the top of the punch down as it cools. This is done by means of standard cabinet-maker's clamps which apply pressure to a wood plate placed on top of the punch after first covering with metal. The material is thereby prevented from shrinking away from the die and is forced into perfect conformity with it.

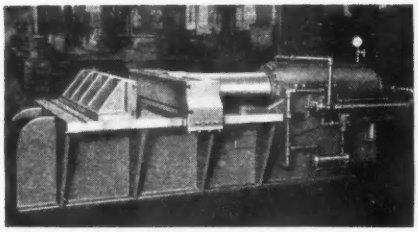
Cooling requires considerable time depending upon the size of the casting, so that the total time required to prepare, case, and cool a plastic punch is more than that required for one of lead. However, when operations permit having a pot of Plastalloy continuously ready to cast, as is done with lead, the over all time will be reduced about one-half, for it requires around six hours to cook up a batch.

The top surface of the cooled punch is not ordinarily smooth nor parallel to the base of the die. Therefore the punch is left in place in the die, after forms and clamps have been removed, and is surfaced parallel to the base of the die. This is done on a planer or similar machine although the operation might as easily be done by a simple set up using a hand router.

Plastalloy may be cut or worked with any kind of cutting tool. It is not abrasive and does not dull tools. Being a thermoplastic, it cannot be ground or sanded, and tends to gum up tools that generate heat rapidly, such as circular and band saws. However, it may be drilled, tapped, planed, or worked with hand woodworking tools. Further, Plastalloy is easy to handle for it weighs but 68 pounds to a cubic foot.

Under proper conditions and within certain bounds of application Plastalloy produces better and more uniform parts, and does it faster than other materials. It is believed that its possibilities have not yet been thoroughly developed. Experiments are now under way at Vega which—if successful—will make it possible to cast a die from a plaster pattern and cast a Plastalloy punch into this die ready to put into work on a press, all with no machining.

New Products



The new 200-ton hydraulic bulldozer, produced by the Beatty Machine & Manufacturing Company, Hammond, Indiana, for use in a war production plant. It has a stroke of 36 in., a maximum opening of 60 in., and a table width of 60 in. The pressing speed is 20 in. per minute and the return speed is 60 in. per minute.

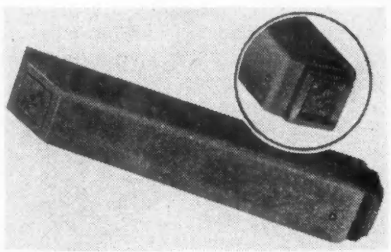
Heavy Duty Cutting Oil

Development of a new heavy duty soluble oil which provides the finish, tool life and cooling that formerly required more than one oil, is announced by Standard Oil Company (Indiana), Chicago, Ill. The new product contains an effective amount of special compounding other than that required to give good emulsion characteristics, according to the company. It is stable in storage, mixes easily, does not gum machine or work, possesses good anti-rust properties, is not injurious to workman's hands and is not susceptible to odor development. It has no harmful effect on machine lubrication where used as recommended by the manufacturer's cutting oil engineers.

A Convertible Marking Tool

A marking tool which can be converted for use in a press or for use with a hammer, has been added to the line of "Champion" interchangeable steel type holders made by Jas. H. Matthews & Co., Pittsburgh, Pa. For hand stamping applications, the removable head is placed over the shank and held in place by means of a set screw, tightened at the side. For press use, the head is removed and the shank is placed into press equipment.

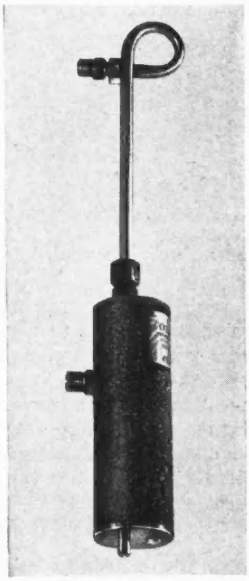
Steel type is changed in the holder by applying slight pressure on a spiral spring, which disengages the spring clip from the type groove. Blank spacers are used where the full capacity of the type slot is not required in the marking application.



Acid etching stamp made by Jas. H. Matthews & Co., Pittsburgh, Pa., using their new synthetic material "S-22". Stamps made of this material are said to be unaffected by acid etching inks.

Humidifier for Steam Heating Systems

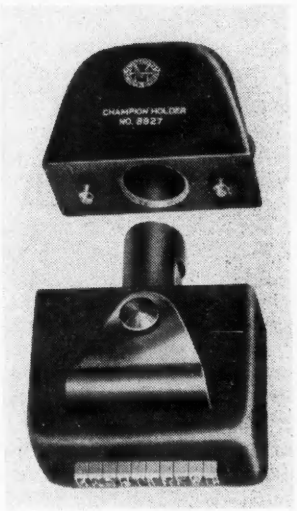
The Skilbeck "E-Humidifiers", distributed by Techtmann Industries Inc., Milwaukee, Wis., are designed for industrial, office and institutional use on steam-heating systems carrying less than 20 lbs. pressure. The makers state that the device will diffuse the exact amount of moisture into the air, when installed on the feed end of radiators or on steam risers. Installation should be made at a point where the condensate will return to the boiler when the radiators are turned off.



The Skilbeck "E-Humidifier"

Gulf Dieselube for Trucks and Tanks

Gulf Oil Corporation, Pittsburgh, Pa., is marketing a new brand of lubricating oil which it calls Dieselube H. D. These oil are made especially for Diesel engines and meet U. S. Army specifications for internal cambustion engines for ground equipment such as trucks, tanks and jeeps. They contain blended ingredients which are said to reinforce their resistance to the heat encountered in tank motors and transmissions, provide increased film strength, and offer increased protection to alloy bearings against corrosion.



Champion Marking Tool.

Mechanized Sweeper for Smaller Plants

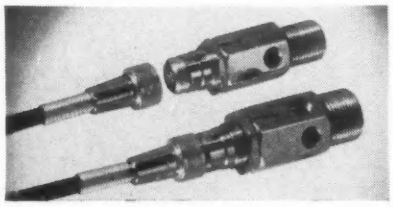
A mechanized sweeper for small and medium sized plants that can be used in close places and which cleans at the rate of 16,000 square feet in open areas, is announced by the Moto-Mower Company, Detroit, Mich. This model, the Detroit Moto-Sweeper, requires only one operator, and picks up machinings as well as lighter dirt and dust.

Detroit Moto-Sweeper

New Products for Aircraft

New Pressure and Detonation Pickups

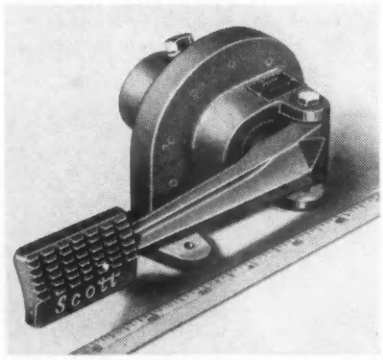
Electro pressure and detonation pickups made by Electro Products Laboratories, Chicago, Ill., are for use with Diesel and gas engines, also pumps, compressors and similar mechanisms, to record instantaneous pressures and other phenomena occurring within the firing or compression chambers. These are magnetic type pickups, having a diaphragm which is exposed to the pressure forces within the cylinder, and



Electro Products Laboratories' Pressure and Detonation Pickups.

a coil assembly. Vibration of the diaphragm produces magnetic flux variations in the coil assembly which provides an output voltage having the same characteristics as the varying pressures developed in the cylinder.

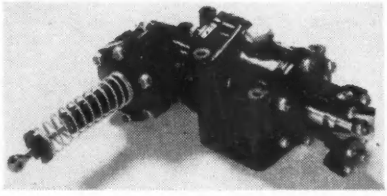
Two sizes are available, Model 3000 which fits into a hole having a ⅞ in.-18 thread, and Model 3000A which fits the standard aircraft engine 18MM spark plug hole. Two types of diaphragms are furnished with each pickup, one for pressures met with in ordinary gas engines and compressors, and the other for high compression engines.



The Scott brake pressure cylinder, developed by the Scott Aviation Corporation, Lancaster, N. Y., for use on light aircraft. It is designed for mounting under the seat, above the floor boards. Its weight is 23 ounces.

Boost Control for Aircraft Engines

The first units of American produced Simmonds-Hobson boost controls, a product of Simmonds Aerocessories Inc., New York, N. Y., are being shipped for installation on aircraft going to the fighting front. This control, which is comparatively new in this country, although in wide use on English planes, provides automatic manifold pressure at various altitudes without the necessity of manual operation of the carburetor controls. The device includes a sensitive bellows or capsule, enclosed in a housing connected to the

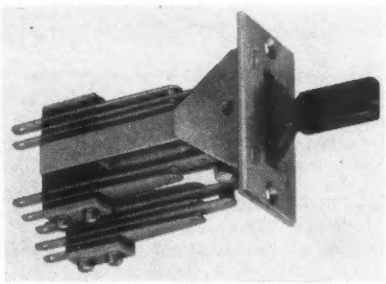


Simmonds-Hobson Boost Control.

engine manifold, with a servo piston and oil slide valve that connects to the engine oil system. With increased manifold pressure, the bellows contracts, causing the slide valve to move. This opens ports which allow oil to flow to one side of the piston, which closes the throttle sufficiently to maintain the pre-determined manifold pressure.

Ustex Yarn for Parachute Harness

The United States Rubber Company, New York, N. Y., is producing a new cotton yarn, called Ustex, which is said to be far stronger than any cotton yarn ever produced. It does not require the long staple cotton which is now a critical military raw material, but uses a type which is readily available. Ustex has been approved by Wright Field for parachute harness, where it will replace the linen and long staple cotton formerly used. The company has received orders for more than a million and a half pounds, and will increase its pilot plant production of five thousand pounds weekly to many times that figure. The first large unit, authorized by WPB, will be completed soon at Winnsboro, S. C.



The Mossman No. 0-42 Lever Switch.

A Versatile Lever Switch

The Mossman No. 0-42 lever switch is designed for use in aircraft, radio, communication, annunciator and fire alarm systems, testing apparatus and a wide range of industrial applications. It is rated at 5 amps 110 volts, maximum. Switches are available from the manufacturer, Donald P. Mossman, Inc., Chicago, Ill., in many combinations of contact assemblies. Contacts, pile-ups and lever actions are assembled to meet the specific requirements.

Aviation Type Universal Joint

Dix aviation type universal joints, made by the Dix Manufacturing Co., Los Angeles, Cal., are supplied in 15 sizes, with hub diameters ranging from ⅜ in. to 4 in. and approximate weights of 4/5 oz to 31 lb.

Hub joints are pin riveted, and heat treated alloy steel is used in the con-

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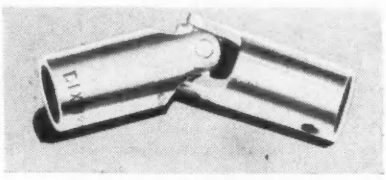

Dix Aviation Type Universal Joint

Tank Production Being Held To December, 1942, Schedules

Medium Tank Engine Not Yet Standardized, Four Types Being Made by Continental, Chrysler, Ford and G.M.

Twenty-five thousand engineers and draftsmen working on combat vehicles for the U. S. Army are largely responsible for the fact that U. S. tanks, armored cars and self-propelled artillery are the best in the world. These engineers and draftsmen are employed by the Ordnance Dept. by such large manufacturers of equipment as Chrysler, General Motors, Ford, International Harvester and Marmon-Herrington and by hundreds of subcontractors that supply tracks, transmissions, final drives, armor plate, electrical systems and machine guns. In 1942 these sources accounted for production of 56,000 combat vehicles, including 23,000 tanks, or 41 per cent of the total.

Maj.-Gen. Levin H. Campbell, chief of ordnance, is authority for the statement that U. S. combat vehicles are the best in the world. This is based on comparative studies made at the Aberdeen proving ground of captured enemy equipment. On the three basic essentials of a combat vehicle—firepower, mobility and protection—U. S. equipment already has proved itself in Libya, Tunisia and Russia under combat conditions. Among the types that have seen battle action are the M-3 and M-4 medium tanks made by Chrysler, Fisher Body and Ford, the Cadillac light tank, the M-7 tank destroyer manufactured by American Locomotive Co., a new type of combat vehicle made by Fisher Body, the jeep, the 37-mm weapon carrier and the half-trac vehicle mounting a 75-mm gun.

Among the factors making for supremacy of U. S. tanks are the stabilizers that permit accurate firing of the largest gun when the tank is in motion, the differential steering arrangement, the suspension mechanism, the comparative impenetrability of the armor plate, the ease of replacing the engine and the use of rubber-jointed track, which greatly increases mobility.

(*Turn to page* 52, *please*)

Tubeless Tire Not Fully Developed

The McGay tubeless tire, which was described in the Dec. 15 issue of AUTOMOTIVE *and* AVIATION INDUSTRIES, has some possibilities for conserving rubber during the present emergency, but improvements are needed to make it really satisfactory and its development beyond the present stage should be handled by Government authorities and the Rubber industry. These conclusions have been arrived at by the Petroleum Industry War Council after analyzing the results of preliminary tests made recently by 19 companies under the direction of the Council, which instituted them to obtain factual information on the McGay proposal under actual operating conditions.

Although application of the tubeless construction to most tires now in service is considered impractical due principally to porosity leaks in the casings, new tires and tires in A-1 condition were found to operate satisfactorily without inner tubes when mounted in accordance with McGay instructions. However, even with them, there also is the drawback of porosity that begins in a casing after several thousand miles due to the kneading action of the cords and rubber, resulting in the loss of pressure and eventually in the formation of blisters. It is believed that a lining in the casing will prevent these conditions and two companies are reported to be developing rubber and plastic compounds for that purpose. If the McGay tubeless tire construction is adopted, it was intended to have Victory tires lined with such a coating by the manufacturers and used tires lined at the time of recapping. Just how much rubber can be saved depends upon the type of lining and the amount that would be required if made of rubber.

The companies operated 193 passenger cars and 42 light trucks equipped with 746 tubeless tires, including 58 spares and 60 recapped tires. The tubeless tire milage totalled 451,416 miles. Since the tests extended over an average period of three weeks under wartime restrictions, the data are not regarded as conclusive. There was no standard test schedule for the cars, how they were operated being left to the companies, which reported the tests results for each car on a form supplied by the Council. Some companies reported successful trials, others just the opposite.

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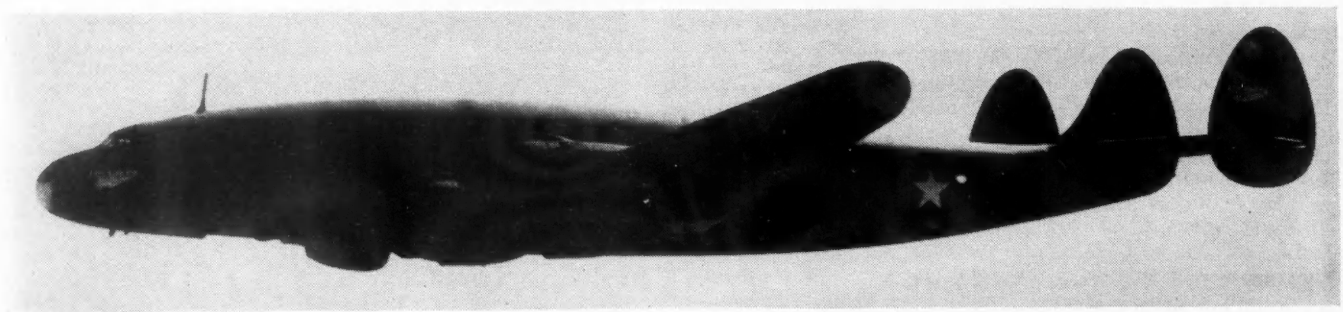
The Lockheed "Constellation"



This is said to be America's largest, fastest and most powerful land-based cargo or transport plane. It is approximately 100 miles per hour faster than present standard airliners, and can transport about fifty-seven persons and a crew of five across the continent in less than nine hours. The cabin is pressurized for flying at 35,000 feet. Four Wright Cyclone engines of the 2,000 horsepower series are used. Each engine has a displacement of 3,350 cubic inches, and is built in two banks of nine cylinders. Like the Wright cyclone 14, the Cyclone 18 has a weight ratio of 1.1 pounds per horsepower. The plane is equipped with a tricycle landing gear.

Shifts in War Strategy Cause Dislocation in Employment

UAW-CIO Wants 40-Hour Week Guaranteed to Employees Who Work Less Than 40 Hours Through No Fault of Theirs

Shifts in war strategy and over-all material developments are factors that are subject to sudden change in the war production program. Thus months of tooling may be washed out by an order cancellation, such as Nash-Kelvinator's for flying boats, or by a change in emphasis, such as Studebaker's shift from 14-cylinder to 9-cylinder Wright aircraft engines when the value of the Flying Fortress as an aerial weapon became recognized. A similar situation is the current emphasis upon combat aircraft and the leveling off of 1943 tank production schedules at December, 1942, totals. All these changes bring a consequent dislocation in employment, cutting hours in some plants below the standard 40-hour week while neighboring factories may be working around the clock on a 56-hour or upward basis.

In order to guarantee the worker's earnings regardless of the fortunes of war, Walter P. Reuther, vice-president of the UAW-CIO and an influential labor spokesman in Washington, is advocating initiation by the government of a national wage policy that will guarantee a 40-hour work week to employees who work less than 40 hours per week through no fault of their own. The cost would be born by the government when the short work week is due to material shortages, schedule changes and altered specifications, and by management when it is responsible. In the name of full employment and high morale, Reuther also advocates regulations requiring all plants to provide full employment of 40 hours per week to be increased to 48 hours per week over a period of 60 days. He also seeks institution by the WLB of an industry wage stabilization policy and creation of wage commissions, composed of government, management and labor, in the automotive and allied war industries to administer a master wage agreement based on the principle of equal pay for equal work.

On the subject of labor morale, Reuther asserts, "It is difficult to convince partially employed workers that more sweat is needed, that absenteeism must end and that strikes are disastrous. Labor (under the plan) would no longer need fear that more sweat will mean unemployment; it would not have to suffer the consequences for material shortages, poor planning or changing army and navy specifications."

Reuther cites cases to bolster his arguments for a guaranteed work week. He says the Oldsmobile plant at Lansing raised output 500 per cent over goals set in the first six months of 1942. In September the company was informed there were sufficient guns on hand and that the contract would be cut 50 per cent. For months a three and four-day work week prevailed, according to Reuther, although it is now back at five days. At Chevrolet in Flint many employees are working a four-day week, according to Reuther, so they have requested permission to transfer to the nearby AC Spark-Plug plant, where a seven-day week prevails in some departments. At Saginaw Steering Gear, according to Reuther, 700 of 3,500 workers were laid off shortly after the plant received the Army-Navy "E" because enough machine guns had been made of that particular type. At the Dodge Main plant in Detroit, Reuther charged that the Chrysler management was hiring new employees while only a 36 or 37-hour work week is in force.

Reuther asserts that many of the new workers to be required is expanding Detroit war plants could be dispensed with if the 700,000 employees now in the area were put on a 48-hour week. He says this would be equivalent to adding 40,000 new workers. However, the UAW-CIO official oversimplifies the many problems involved. The fluidity of war makes constantly changing demands upon the manufacturers. There must be a certain amount of flexibility in the labor pools of the various plants to permit them to meet these situations. A plant cannot release all its skilled men in a certain classification to another plant when the first plant may be called upon shortly to expand its schedules. It is this constant change of schedules that prompts

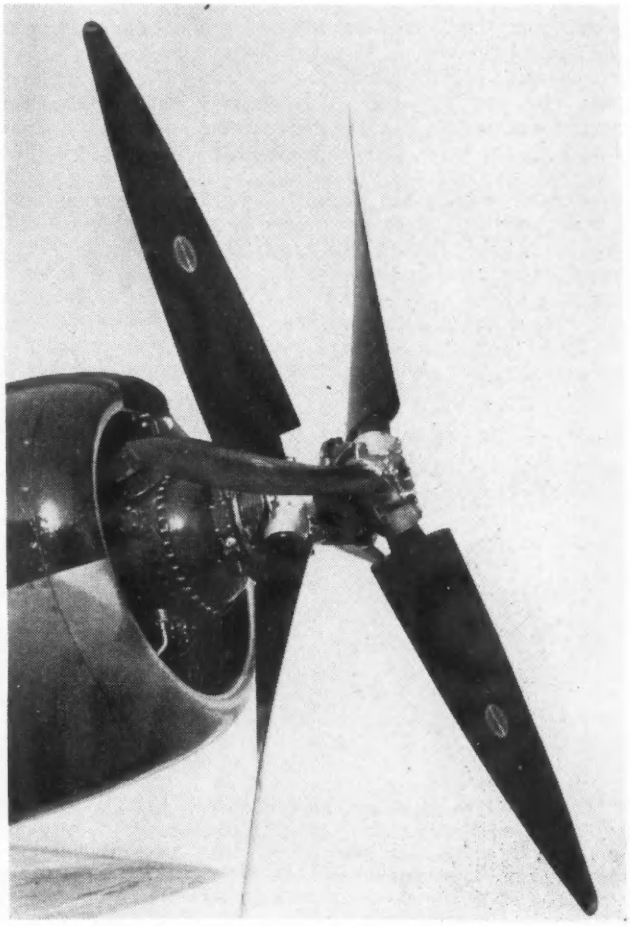
(Turn to page 54, please)

A.S.T.E. Will Hold Tool Progress Exhibition

It has been announced that the American Society of Tool Engineers, reversing its decision, has authorized the holding of a 1943 Machine and Tool Progress Exhibition in connection with the Society's annual meeting in Milwaukee March 25 to 27.

Demand for the show, it is said, has arisen primarily out of the urgency for simplifying the Nation's war production job, the increasing use of unskilled labor, the greater seriousness of the man labor situation and the need for further marked increase in production combined with the maximum conservation of materials.

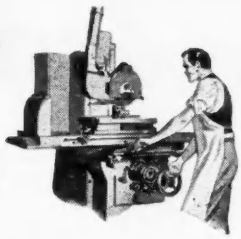
The Exhibition and the Technical Sessions will be held in the Milwaukee Auditorium.



Counter-Rotating, Constant Speed Propeller

This development of Hamilton Standard Propellers Division of United Aircraft Corporation is said to be the first constant speed, counter-rotating propeller to fly in this country.

To the Skeptic who hasn't yet tried the POR-OS-WAY WHEEL



THE MEN in the armed forces want all you can give them—NOW! You may, as hundreds of war plants have already proved, increase your precision grinding production 2 to 5 times per man per machine with the Por-os-way wheel. Try it!

A YEAR AGO we introduced to industry a new precision grinding wheel. We were confident, after three years' research and scores of actual trials on production work that this new wheel, Por-os-way, would produce 2 to 5 times more work per man per machine. And we said so. At first there were few believers. Our statement seemed incredible. But there was a war to be won. War plants by the score tried Por-os-way, probably with more hope than conviction. They did not fully realize, then, that Por-os-way, being an entirely new kind of wheel, could not be limited by comparison with wheels they had been using. But skepticism is disappearing. Many operators now *know* that Por-os-way's patented honeycombed structure cools each grinding point between contacts, practically eliminating "burns" in vital war work. Many know that they can double or treble the depth of former cuts and grind in fewer passes of the wheel . . . have seen how the Por-os-way wheel holds its corner and resists "loading", reducing the number of dressings necessary. Many have proved to their own satisfaction that the life of a Por-os-way wheel is at least equal to or better than previous wheels, and know that Por-os-way can produce 2 to 5 times more work per man per machine. But even among Por-os-way's most enthusiastic users, some few are *still not pushing Por-os-way to the limit of its possibilities.* We want you to give this wheel "the whole works." We want you to see for yourself it is all others say it is. Send for "Facts about Por-os-way", with a "prescription blank" for a trial, run to your requirements.

2 TO 5 TIMES MORE WAR PRODUCTION PER MAN PER MACHINE

War plants say, "Tell others what Por-os-way has done for us."

WAR PLANT A—Job: Surfacing oil-hardened, high-speed steel blanks on B & S grinder at 6200 SFPM.

Results: Por-os-way removed .050" in one pass, against .020" previously. Por-os-way wheel lasted 2½ times as long as former wheel, required no dressing, produced no burn, held shape and corner while grinding.

WAR PLANT B—Job: Grinding high-speed cutter tool steel on LeBlond No. 1 at 4750 R.P.M.

Results: Por-os-way increased production 300%. Held a true edge in grinding a *complete* gear cutter. No burning, no loading. Free, cool cutting without dressing. Good finish.

WAR PLANT C—Job: Internal wet grinding on Bryant 16-A machine at 8946 R. P. M. on hardened tool steel—SAE 41/50. Precision grinding.

Results: Obtained 400% better production. Cut fast, free, and cool. Diamond dressed only occasionally to retain shape.

POR-OS-WAY* a new RADIAC* PRODUCT

A. P. DE SANNO & SON, INC.
NEW YORK, CHICAGO, PITTSBURGH, CLEVELAND, DETROIT, LOS ANGELES

PHOENIXVILLE, PENNA.
Western Gateway to VALLEY FORGE

*T. M. Reg. U. S. Pat. Off.

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Narrow fluctuations of general business activity continue. The seasonally adjusted index of *The New York Times* for the week ended Jan. 9 declined to 134.7 per cent of the estimated normal from 136.8 for the preceding week, as compared with 132.6 a year ago. The index of *The Journal of Commerce*, without seasonal adjustment, for the same period rose to 127.4 per cent of the 1927-29 average from 120.1 a week earlier.

Department store sales during the week ended Jan. 9, as reported by the Federal Reserve Board, were 6 per cent above the corresponding level in 1942, as compared with a similar excess of 5 per cent shown for the week before. For the period of four weeks then ended, the total was 10 per cent greater than a year ago.

Railway freight loadings during the week ended Jan. 9 totaled 716,272 cars, 15.3 per cent more than for the preceding week but 2.8 per cent less than the number a year earlier.

Electric power output during the same period declined more than seasonally and was 13.8 per cent greater than a year ago, as against a similar excess of 14.9 per cent shown for the week before.

Crude oil production in the week ended Jan. 2 averaged 3,870,600 barrels daily, 10,100 barrels below the figure for the preceding week and 145,300 barrels less than the average output recommended for December by the Petroleum Administration for War.

Average daily production of bituminous coal during the week ended Jan. 9 was 1,830,000 tons, as compared with 1,860,000 tons in the week before and 1,821,000 tons a year ago.

Engineering construction contracts awarded in the second week of 1943, totaling $53,000,000, were 36 per cent below the corresponding figure in 1942, according to *Engineering News-Record*.

Business failures in the first week of this year dropped to 95, as compared with 105 in the preceding week and 203 at the beginning of 1942, according to the Dun & Bradstreet report.

Professor Fisher's index of wholesale commodity prices for the week ended Jan. 15 rose three fractional points to 110.1 per cent of the 1926 average, a new peak, as against 102.6 a year ago.

Member bank reserves declined $185,000,000 during the week ended Jan. 13, and estimated excess reserves declined $180,000,000 to a total of $2,150,000,000. Business loans of reporting members fell $44,000,000 in the preceding week and stood $692,000,000 below the total a year earlier.

Propeller Plant Enlarged

The American Propeller Corporation, Toledo, Ohio, will increase present plant capacity by 50 per cent with the purchase of additional machinery and equipment, it was announced by William F. Wise, president of American Propeller and executive vice president of the Aviation Corporation.

With the acquisition of the additional equipment, American Propeller will become the largest hollow steel propeller blade manufacturers in the country.

Battlefront Developments Will Influence Material Requirements

Output of Steel Plates Speeded Up to Maintain Merchant Marine Tonnage at Highest Levels

By W. C. HIRSCH

Whatever clarification the Controlled Materials Plan, work on which continues according to schedule, may bring to the metal distribution problem, day-to-day developments on the battlefronts will continue to be the major influence in the forming of opinions as to whether more or less of a certain kind of material will be needed for the war effort in the months to come. Increased activity in the air is making the stepping up of the aviation industries' steel needs to the limit of their construction facilities more of a certainty than probability. This will mean that larger tonnages of certain alloy steels will be required, and denied to less important uses, although these may also be of a military character. In some descriptions of steel, the impact of war developments is almost immediate, as, for instance in the case of steel plates. Their output has been ordered speeded up to the limit of existing rolling facilities, so that, in spite of sinkings by German submarines, merchant marine tonnage can be maintained at the highest possible level. What unconverted strip steel capacity remains, is being subjected to further scrutiny with a view to adding as much of it as possible to the rolling of plates. Output of sheets and strip steel will be pared further as a result of these measures, but is considered of less importance under the circumstances. Notable steel savings are reported to result from recently developed refinements in the piercing of shell forgings and drawing them to size.

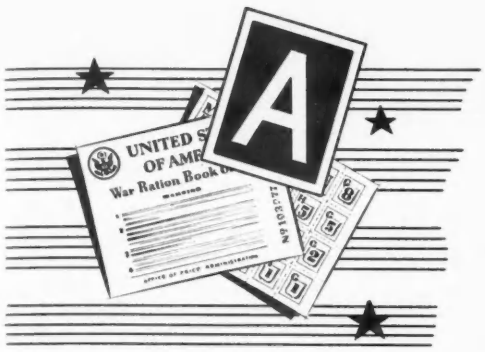
Controversies at this early stage of the Controlled Materials Plan preparatory period over demands by some of the Claimant Agencies are accepted as an excellent indication that these difficulties can be ironed out before, rather than after, allocation, thus giving the latter the finality called for by the plan. Lend-lease reservations are, it is feared, likely to give more trouble than those of other claimant agencies, as restriction to immediate requirements, a basic principle of the CMP, entails serious difficulties in the scheduling of lend-lease requirements. Publicizing of plans for the systematic gathering and shipment of battlefield scrap, which formed an important topic for discussion at a recent meeting of scrap iron interests in New York, has brought out a fresh flood of fault-finding with exports of steel in the form of ingots and other semi-finished descriptions, the scrap from which in the finishing processes does not come back to the United States. The scrap situation, however, is much more favorable, nearly all of the steel mills being provisioned with material that will keep them running during the current quarter.

The leading producer of magnesium recently announced a price reduction of 2 cents a lb, and specific maximum prices for magnesium scrap, ranging from 5 to 12 cents a lb and of from 16 to 21½ cents for remelt magnesium, have been set by the Office of Price Administration.

Although there is general approval of reiterated warnings from official quarters of the need of conserving every possible pound of tin, those who formerly were leading factors in the importing of the metal say that the outlook for adequate supplies to take care of all war needs this year is reassuring.

Sperry Gyro-Compass

The Dodge Division of Chrysler Corporation has gone into quantity production of Sperry gyro-compasses, which have become a vital machine of war. They are used on ships of all kinds plying in mine-infested waters, as the device used to combat magnetic mines interferes with the action of magnetic compasses.



Star-Spangled RATIONING

In wartime we expect our fighters to have better guns for knocking off Nazis than we keep around home for knocking off squirrels.

In wartime we are glad to use our cars a lot less so the boys in Africa and Australia can use their tanks and planes a lot more.

In wartime we are proud to turn over our factories to build products that fight, instead of the things of peace.

In wartime we are happy to buy bonds that help carry something more than moral support around Murmansk way.

But how far personally are we really willing to go to help win the war?

There are men who hid hundreds of gallons of gasoline in their basements before rationing.

There are women who tucked their closets full of sugar before the lid went on.

There are people who wore themselves footsore buying up coffee before it was restricted.

These folks perhaps have no sons in the Solomons, or husbands, brothers or relatives in Africa.

They perhaps feel only the cold wind on their necks when they uncover for the Star-Spangled Banner.

They for sure are in the minority—there just can't possibly be more than one American worm to every thousand American patriots. As makers for years of essential parts for automobiles and airplanes as well as products for home and farm, we believe the way Americans are wearing their "A" cards indicates the spirit with which they will meet all other forms of wartime sharing and rationing.

We believe the true American breadwinners and housewives and their thinking children—and there are 130 million of them—see the advantage of all Americans at home sharing alike—see the need of first providing adequate food and supplies for fighting forces and fighting allies.

★ ★ ★

We believe if there isn't as much food or gasoline or clothes to permit everyone to have as much as he wants, the supplies that are available should be divided as equally as possible so that all may have a fair share.

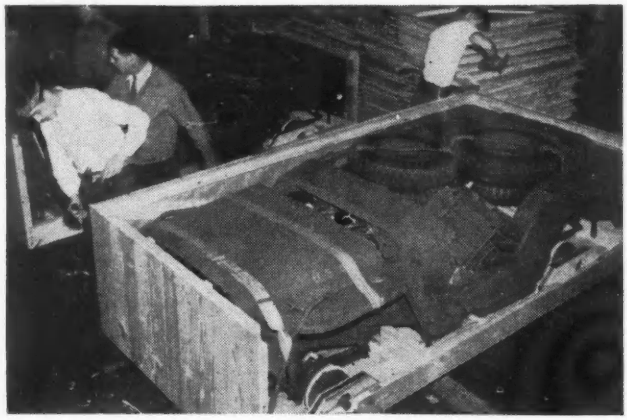
We believe rationing should be maintained only as long as these wartime needs are present.

We believe rationing in wartime is not regimentation

—it is merely applying the Golden Rule clear across the board in a good cause.

BORG-WARNER CORPORATION, *Chicago*

Makers of precision products . . .
on the road, in the sky, on the farm, in the home



A new crate, developed by Willys-Overland Motors, occupies only 141 cubic feet. It enables a ship to carry 11 Jeeps in the space previously required for 10 of the scout cars.

MEN . . . . . .

Announcement has been made of the election of **Edwin Olney Jones** as a vice-president of the Federal-Mogul Corp. Mr. Jones continues as sales manager of the company's original equipment division.

Promotion of **Raymond E. Peterson,** former Milwaukee district traffic manager of United Air Lines, to become assistant to **R. F. Ahrens,** personnel director of United, has been announced.

Leslie E. Hess has been elected chairman of the board of The J. G. Brill Co. to succeed **Charles J. Hardy,** who will continue as chairman of the executive committee. **Ronald R. Monroe,** vice-president, succeeds Mr. Hess as president.

Richard E. Palmer, of Niagara Falls, formerly in the aircraft division of the WPB, has been appointed assistant to **O. L. Woodson,** vice-president and assistant general manager of the Bell Aircraft Corp. He will be assigned to problems concerning manufacturing processes. Announcement is also made of the appointment of **William B. McBride** to the position of production manager.

S. Caplan, who has been research chemist with the Harvel Research Corp., has become the Research Manager and Acting Technical Director of the Irvington Varnish and Insulator Co. He succeeds **C. F. Hanson,** who has been appointed chief consulting engineer.

W. G. Paton, of Cleveland and **W. R. Engstrom,** of Seattle, have been made vice presidents of the Austin Co.

L. F. Skutt, formerly manager of the Chicago Zone, has been appointed general sales manager of the Nash Motors Division of Nash-Kelvinator Corp.

Louis G. Bissell has been elected board chairman of Mack Trucks, Inc., succeeding the late E. C. Fink. **C. T. Ruhf,** formerly operating vice president, has been elected president of Mack Mfg. Corp., the manufacturing subsidiary, succeeding Mr. Fink, and executive vice president of the parent company.

Peter N. Jansen, formerly director of manufacturing, has been named general manager of the Aeroplane Division of Curtiss-Wright Corp. and placed in charge of all the division's manufacturing plants. **J. P. Davey,** formerly works manager of the St. Louis Aeroplane Division, has been appointed general manager of the Columbus plant, succeeding **J. A. Williams,** who has returned to the Aeroplane Division offices in Buffalo to handle government contracts and subcontractors.

J. Widman Bertch, formerly vice president of Lee Anderson, Inc., Detroit advertising agency, has been appointed deputy director of the Salvage Division of WPB. He had been chief of the special projects salvage branch.

James S. Knowlson has resigned as vice chairman of WPB to resume his duties as board chairman and president of Stewart-Warner Corp. He will be retained by WPB as a consultant or special assistant.

Byron C. Foy, vice president of Chrysler Corp. and president of the DeSoto Division, has entered the officer's training course of the U. S. Army Air Forces at Miami Beach, Fla.

Kinner Motors, Inc., Glendale, Cal., has announced the election of the following officers. **Earl Herring,** president and general manager; **Gunnar Edenquist,** vice president and assistant general manager and **Walter G. Milka,** vice president in charge of production.

Chairman Donald M. Nelson of the War Production Board today announced the resignation of **Ernest Kanzler** as Director General for Operations.

(*Turn to page 56, please*)

PUBLICATIONS

The Bristol Co. has published a series of bulletins covering **automatic control and recording instruments** for industrial furnaces, dryers, kilns and ovens. The bulletins are bound together in loose leaf form, are well illustrated and include application drawings and wiring diagrams. Material included gives a wide selection of types and combinations to meet the needs of manufacturer.*

Micromax Electric Control, a new 29-page catalog, has been issued by Leeds and Northrup Co. It describes control equipment capable of handling any process which can be controlled by positioning a valve or other regulating device. Diagrams and text explain in detail how the equipment is adjusted to fit the needs of a particular process.*

An explanation of **thermocouple construction and assembly,** designed to aid pyrometric instrument users in selection of proper types, is contained in Wheelco Comments — November - December issue. Described and illustrated are thermocouple insulators, connector blocks, heads, protecting tubes, etc.*

A new booklet, **Facts About Multiple Thread Milling Cutters,** issued by Barber-Colman Co., has been designed to assist the users of thread milling cutters in ordering and using them for war production work.*

New data on **Oilseals and Greaseals** is the title of a new bulletin published by the Gits Bros. Mfg. Co. It contains detailed information, recommendations, applications, diagrams, listings, prices, etc., on its line of Oilseals and Greaseals for aircraft, motorized units, etc.*

Anker-Holth Mfg. Co. has issued a new catalog, **Airgrip Pneumatic and Hydraulic Holding Devices,** which describes, illustrates and gives specifications for three jaw universal chucks, revolving air cylinders, shell holding equipment, collet chucks and expanding arbors, etc.*

Electronics—A New Science For A New World, is the title of a new, pictorial booklet issued by General Electric Co., presenting the general story of electronics. A bulletin describing the complete line of welding accessories for women has also been issued by General Electric Co. It is titled **Arc Welding Accessories for Women.***

Greenlee at War is the title of an attractive booklet by Greenlee Bros. & Co. In addition to a short description of its growth during the past 77 years, it lists, pictorially, the various machines and tools being supplied to American industry for production of war materials.

Research Company of America, 341 Madison Ave., New York City, has released a new chart, primarily as a service to men interested in the broad subject of marketing. It is titled **A Basic Marketing Chart of the United States.**

George J. Hagan Co. has issued a new bulletin describing and illustrating its **Rotary Forging Furnaces.** The bulletin also gives detailed production facts on various Hagan installations.*

Bulletin No. 500 on **Magnesium Melting and Alloying Furnaces,** has been published by Fisher Furnace Co. It covers a complete range of types and sizes of Fisher furnaces.*

Rogers Machine Works, Inc., has issued a new catalog describing and illustrating the latest **Rogers Perfect 36 Vertical Turret Mills** for boring, drilling and turning. Included also are condensed specifications on the Standard and High Speed models.*

A new **Silverstitcher** folder issued by Acme Steel Co. describes and illustrates the various standard and special types of carton stitchers available to shippers of war products.*

Fansteel Metallurgical Corp. has brought out a new booklet titled **Fansteel Electrical Contacts—An Engineer's Manual** which is intended as an aid to designers of electrical equipment and appliances. Detailed descriptions of contact metals, alloys and powder metallurgy compositions, together with a Contact Selector Chart to help the designer select the correct contact are included, also two pages of drawings and instructions detailing efficient and convenient assembly methods.*

Bulletin No. 30 on **The Care and Maintenance of Fractional Horsepower Motors,** by Dumore Company, is aimed toward instructing the operator in the proper care of his motor. Correct procedure for general cleaning and overhauling is fully explained, as well as the most efficient methods for cleaning and replacing sleeve bearings, ball bearings, etc.*

The Watson-Stillman Co. has issued the following new literature. Bulletin A-4, an illustrated manual of **globe and check valves.** It is divided into six sections, each of which can be located by means of an identifying tab. Headings include bronze globe valves, forged steel globe valves, balanced stop valves, bronze check valves, etc.* Bulletin 740-A on **wire rope shears.** It is divided into two sections for easy reference, one devoted to the hand-operated shear for clean, fast cutting, the second to hydraulically operated shears for heavier work.*

* Obtainable through Editorial Dept., Automotive and Aviation Industries, Chestnut and 56th Sts., Philadelphia. In requesting any of these publications, please give date of issue, your company connection, and position.

CALENDAR

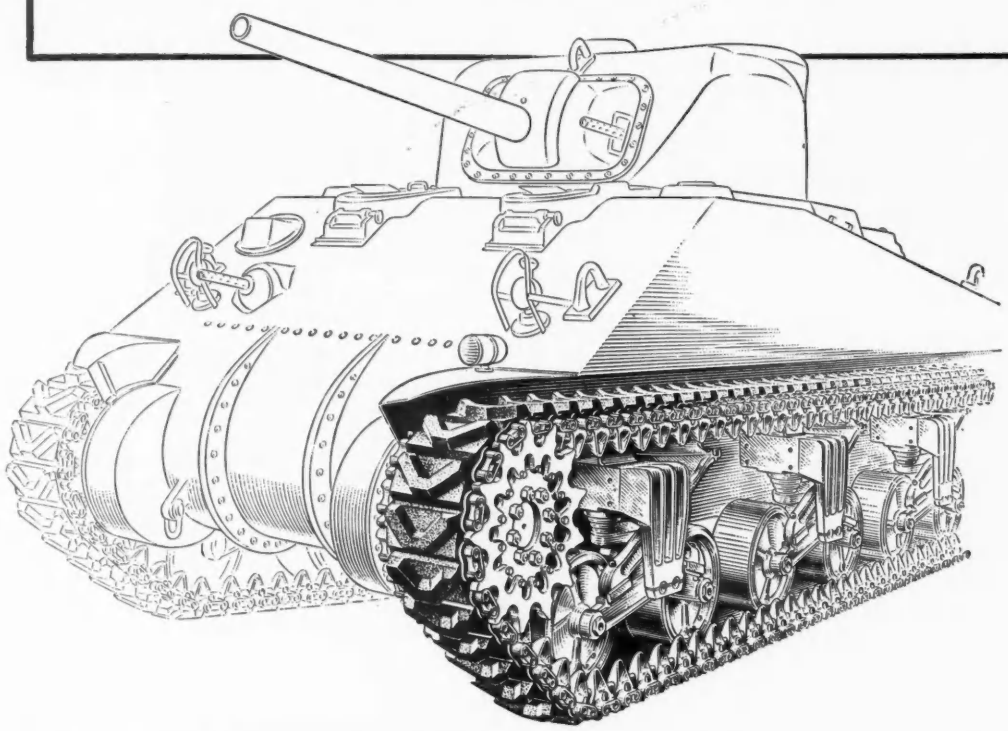
Conventions and Meetings

American Society of Tool Engineers, Mulwaukee, Annual Meeting
March 25-27

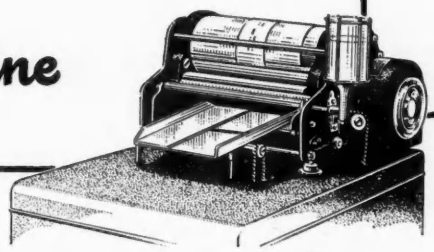
Midwest Power Conference, Chicago
April 9 and 10

American Foundrymen's Association, St. Louis, Annual Meeting..April 28-30

the Tank took a hint from



the Duplicating Machine



THERE'S NO maintenance man in most offices, making regular trips with a grease gun to see that bearings have plenty of lubrication. That's one of the reasons why builders of business machines selected the Torrington Needle Bearing to lengthen the service life of their products.

With Army tanks, of course, it's entirely different. They're regularly and thoroughly inspected by highly skilled maintenance crews. But when a tank comes back from the battlefield, and the crew starts racing against time to get it ready for another lightning dash against the enemy, there's a big advantage in having bearings that seldom need attention. So the tank designers, like the business machine builders, turned to the Torrington Needle Bearing because its high load capacity helps prevent overloading or breakdowns, because its simple, effective system of lubrication allows the bearing to run for long periods without *any* attention at all. And its ready availability helps speed the job of tank production.

WHEN YOU PLAN YOUR POST-WAR DESIGNS, here's something to think about. Your peacetime customers will probably be looking for products that last longer, need less attention, work more efficiently—and the Needle Bearing can help you give them what they want. You will find a long list of typical Needle Bearing applications in Catalog No. 107. One of them may give you an idea for your own product—and Torrington engineers will be glad to help you work out the details.

THE TORRINGTON COMPANY

Established 1866 • Torrington, Connecticut, U. S. A.

Makers of Needle and Ball Bearings

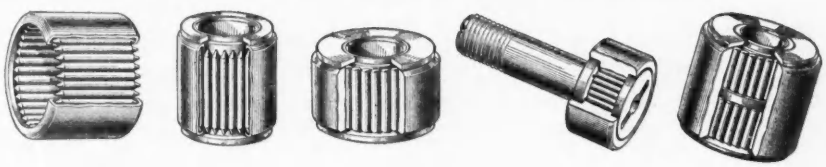
New York Boston Philadelphia Detroit
Cleveland Seattle Chicago San Francisco
Los Angeles Toronto London, England

LET'S GO! U.S.A. KEEP 'EM FLYING

TORRINGTON NEEDLE BEARINGS

KEYED TO TODAY'S NEEDS

AND TOMORROW'S TRENDS



The Lockheed AT-18

The Lockheed Hudson is shown in a new form known as the AT-18. Based on the Hudson III, the AT-18's primary function is the training of advanced students in aerial gunnery. Most of the interior equipment has been removed, and the cabin stripped down to a shell within which are seats, inter-phone equipment and radio for a crew of two and one student. A low-pressure oxygen system is provided, and there is a target windlass installation which lets the target sock out through the tunnel gun opening.

Tank Production Held to Schedule

(*Continued from page* 45)

Before these combat vehicles go into battle, they are thoroughly tested by Ordnance experts versed in battle conditions. The Packard Proving Ground at Utica, Mich., and the General Motors Proving Ground at Milford, Mich., both close to many of the combat vehicle manufacturers located in Detroit and Flint, are used for trials of the new tanks and mobile weapons, just as in peace-time they were employed for passenger car and truck tests. The Ordnance Dept. also is negotiating for use of the Studebaker Proving Ground at South Bend, Ind.

To try out armed equipment under torrid desert conditions, an Ordnance center is maintained at Camp Seeley, El Centro, Cal., where the climate and sand are similar to that found in Libya. The Ordnance Dept. also maintains a winter test base in one of the coldest areas of Canada to test equipment under extremely low temperatures such as those found in Alaska and Northern Russia. A machine shop, welding equipment and other maintenance supplies are on hand for work on the tanks and military trucks operating there. Civilian representatives of the SAE War Engineering Board also lend their expert advice as the vehicles run in 40-deg below zero temperatures. Experience with batteries, starters, lubricants, both engine and chassis, and tires supplements the experiments carried out in the "cold room" laboratories of automotive factories in warmer climes. One of the most difficult problems is developing a lubricating oil with a pour point low enough to eliminate the need for dilution.

Superior firepower is one of the biggest advantages boasted by U. S. tanks. Both the M-3 and M-4 medium tanks mount a 75-mm gun as the chief weapon, although in the latter it is more potent due to being mounted in the top turret, where it can revolve in a complete circle. The experimental 60-ton heavy tank carries a 3-in. gun in the turret. There is no reason to believe that these are the ultimate in tank armament. The "secret weapon" that helped Gen. Montgomery rout Marshal Rommel was the M-7 tank destroyer made by American Locomotive. This consisted of an open M-3 tank chassis mounting a 105-mm howitzer. It also had a conning tower arrangement at the right front mounting an anti-aircraft gun. Production layouts of the M-7 were drafted in 16 days last spring and the first experimental model was on the Aberdeen proving ground three weeks later.

Two other secret vehicles are in production and will help in the eventual rout of the Axis forces. One of these is a new type land combat vehicle which with the M-4 medium tank forms a combination that has smashed everything set before it in North Africa. Fisher Body, which is building this vehicle as well as the M-4 tank, delivered experimental models of the former to the Ordnance Dept. within 60 days of placing of the order. In December Cadillac produced a new secret mobile weapon which Army officers predict will be more of a surprise to the enemy than the M-7.

Cadillac only recently was permitted to announce its production of light tanks. The letter of intent was received Nov. 13, 1941, and the first tank was shipped 138 days later, only 55 days after building of passenger cars ceased. Shipping of tanks on regular schedule began in May, 1942. Production of another combat vehicle began in September. Seventy per cent of Cadillac's major automotive manufacturing equipment was converted for tank use. Cadillac has more than 600 subcontractors on this work.

The standard tank engine, which Gen. Campbell says is "something to be desired," still is in an uncertain status, with four types of medium tank power plants being turned out by Continental, Ford, Chrysler and GM Diesel. Continental is charged with the production of more tank engines in 1943 than any other company, according to President C. J. Reese, which would seem to discount the naming of any other tank engine as "standard."

Due to prior emphasis placed upon aircraft, naval escort vessels and merchant vessels, especially for alloy steel, tank production has been leveled off on the basis of December, 1942, schedules, according to Gen. Campbell. This means that tank output will remain on a relatively even basis unless there is a marked change in the material situation or in strategic requirements.

40 YEARS AGO

Although the automobile cannot climb fences to circumnavigate snow drifts on country roads, as one of the contributors in your recent Doctor's Number states, yet a very striking instance of the auto's superiority under severe traffic conditions was observable on Monday, January 26, after Sunday's severe snow storm.

New York asphalt streets were very slippery, and it was pitiful to note the painful attempts of horses to obtain a foothold on the icy surface while the motor propelled vehicles rolled right on by without any trouble whatever. The heavy electric carriages were particularly successful owing to better wheel traction, due to their weight.

From *The Horseless Age*, Feb. 4, 1903.

Good Automatics DESERVE Good Operators

Good operators can get the most from any machine, and, because seconds count so much, automatics should be kept in use at peak efficiency.

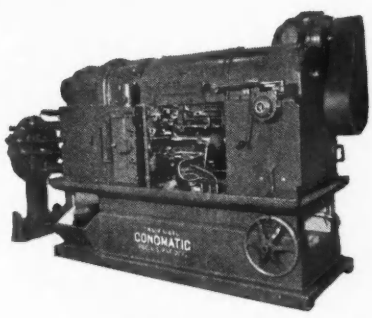
The Departmental Design of Conomatics helps new operators to learn faster. The extra rigid cross-slide construction permits holding heavier forming cuts to closer tolerances.

Cone handbooks are useful in helping both new and experienced operators to get excellent results from Cone machines.

PRIME YOUR PRODUCTION PULSE—SPECIFY CONES

CONE AUTOMATIC MACHINE COMPANY, INC.

WINDSOR, VERMONT
U. S. A.



Obituary

Henry C. Pierle, 62 secretary and general sales manager of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, died January 14 at Christ Hospital, following a heart attack and short illness of several weeks.

Franklin Magill, founder and president of the New Products Corporation, Chicago, Ill., succumed to a severe illness on January 13. His friends and associates in the industry will remember him as one who had faith in the future of automatic transmissions and backed the development of the Mono-Drive transmission, in the early years when the automatic transmission was almost an academic principle.

Edgar Palmer, 62, board chairman of New Jersey Zinc Co., died Jan. 9 at his home in Princeton, N. J.

William L. Grimm, 59, president and treasurer of the Peerless Marine Motor Corporation, Buffalo, N. Y., died January 14th while riding in his automobile. He was widely known in marine motor circles and held a number of patents. With his brother, the late Edward Grimm, he established the Peerless Company many years ago. In 1928 he purchased his brother's interest and became sole owner.

Dislocation in Employment

(*Continued from page* 46)

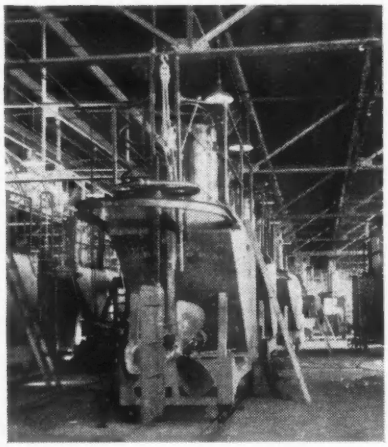
Reuther to ask for a guaranteed work week. In pre-war automobile manufacturing days, the production schedules were geared to sales demand, which fluctuated with buying power and the appeal that the particular model enjoyed with the public. Now war production is geared to the rapidly changing aspects of a global war. Reuther is merely asking for the pre-war annual guaranteed wage idea in a new form.

Most drastic action ever taken in the Detroit area as a result of the sporadic wildcat strikes that have plagued war plants in recent months occurred when the Bohn Aluminum & Brass Corp. discharged seven workers, at the request of the Army Air Forces. An eight worker who was employed at Packard after figuring in the work stoppages that took place three times in four days at the Bohn plant during December also was fired on orders of the AAF. The eight were found guilty of responsibility for the strikes after a 2-week hearing. Among those fired by Bohn were a chief shop steward and a woman worker. All eight are barred from work in plants holding AAF contracts, according to Col. George E. Strong, Air Force plant protection chief who made the investigation. It was further revealed that two of the instigators of the wildcat strikes had prison records, one having served more than six years of a 10-30-year term for kidnapping and another being on parole after serving a federal sentence for theft of a WPA check.

The UAW-CIO has asked for reinstatement of six of seven electricians who were fired by Briggs Mfg. Co. in November in a jurisdictional dispute in which the Mechanics Educational Society of America attempted to organize maintenance workers at the Briggs aircraft plant who already were working under a UAW-CIO contract. The WLB recently had severely reprimanded the MESA for calling a sympathy strike in 15 other plants over the incident and refused to order reinstatement of the seven men, who were MESA members. The MESA has been competing with the UAW-CIO in organizing maintenance workers.

Wage raises have been granted a number of workers in war plants by the WLB in recent weeks. A six-cent per hour raise was granted to 3,500 maintenance workers in General Motors plants in certain classifications that were omitted from a previous raise approved last October. A five-cent per hour raise was granted to 5,000 GM tool and die workers, which is in addition to a 10-cent per hour boost approved last October. This brings the GM scale closer to that prevailing in the independent shops. A total of 6,671 employees of Murray Corp. of America were awarded a four-cent per hour raise, retroactive to June 1, 1942. An additional six cents per hour was granted Murray tool and die workers. A general raise of four cents per hour, also retroactive to June 1, 1942, was allowed 21,000 Packard Motor Car Co. employees. Packard workers with one to five years' seniority were awarded an annual vacation bonus of $45 and those with more than five years $90.

Big Outboard Engine



Assembly line in the Kercheval body plant of the Chrysler Division, Chrysler Corporation, with a marine tractor or "sea mule" under construction. The model shown in the foreground is the 2-A, large numbers of which have been delivered. This unit can be attached to any barge, scow or other flat-bottomed cargo carrier to give it independent locomotion. The rudder and propeller can be raised or lowered, so that they will be above the keel line in shallow water. A Chrysler eight-cylinder marine engine furnishes the motive power.

Kahn Elects Officers

At a recent meeting of the Board of Directors of Albert Kahn Associated Architects and Engineers, Inc., held in the offices of the company in Detroit, a complete roster of officers was elected.

Louis Kahn, who for many years has been secretary-treasurer and executive head of the Corporation, was elected president. Mr. Kahn has been associated with the organization since 1909. He is a registered architect and a member of the American Institute of Architects, Michigan Society of Architects and Detroit Engineering Society.

Three vice-presidents were elected: Sheldon Marston, George H. Miehls and Robert E. Linton. George K. Scrymgeour was elected secretary and Paul Saulson is the new treasurer.

Hendy Acquires New Plant

The Joshua Hendy Iron Works, Sunnyvale, California, has acquired the Crocker-Wheeler Electric Manufacturing Company of Ampere, N. J., the Pomona Pump Co., of Pomona, Cal., and St. Louis, Mo., together with its subsidiary Westco Pump Division. In addition to the plants in Pomona and St. Louis, a new twenty-five acre plant located at Torrance, Cal., and equipped for the manufacture of pumps, has been purchased and turned over to Pomona Pump Co., Division of the Joshua Hendy Iron Works.

Tubeless Tire Not Fully Developed

(*Continued from page* 45)

Ordinary tire sealing materials did not prove satisfactory for use with the tubeless tires, particularly when the operations were at temperatures below freezing. In the case of the spare tires, sealer had been applied to 11 of the 17 failures. A classification of the tubeless tires at the end of the test, exclusive of spares, has been compiled as follows:

	Tires	Good	Fair	Poor	Failures
With Sealer	371	235	46	26	64
Without Sealer	303	198	29	14	62
Total	674	433	75	40	126

Tires were classified in the Poor or Failure catagories because of a pressure loss of above 4 lb. daily or actual failure. Thirteen of the failures resulted from blow-outs, formation of casing blisters and sidewall failures.


PERISCOPE
214799
NOW a tank can see over a hill! Dependable Lycoming-powered Stinson "Sentinel" ships are acting as periscopes for our mechanized units operating in the four corners of the earth. Through blistering heat and tropical storms Lycoming power never falters in the vital role of powering the periscopes of Uncle Sam's "land dreadnaughts."
LYCOMING
AIRCRAFT ENGINES
The Training Plane Engine of Today
... The Private Plane Engine of Tomorrow
★
Lycoming Division, The Aviation Corporation
Williamsport, Penna., U. S. A.
414

General Principles of Industrial Radiography

(*Continued from page* 25)

detect difference in light intensity. All of the above factors must be taken into consideration in discussing the physical basis of radiographic inspection and the relation between the size of defect recorded and the technique used.

The density D of the developed film is defined by $D = log_{10} L_o/L$ wherein L is the intensity of the light transmitted through the film when an intensity L_o would be received by the film if it were removed from the light beam. The ratio L_o/L depends to some extent on the arrangement of the measuring apparatus. Questions on intensity and sensitivity may be worked out somewhat in this manner and for further reference the excellent work of Drs. Lawrence and Ball of the National Research Bureau, Ottawa, should be consulted. With regard to metal thickness it is most convenient to plot thickness in multiples of the half value layer, in terms of the incident exposure factor E_o. The half value layer, h, is that thickness of metal which reduces the intensity 50 per cent and it is related to the absorption constant μ by the equation $h = 0.692/\mu$.

For proper procedure constant kilovoltage selection and time of exposure for a given thickness of metal with relation to its atomic number should be worked out and standardized so that percentages of error will be reduced and materials allowed to proceed on the production line with the greatest speed possible after satisfactory inspection has been made.

Scattered radiation is one of the great problems in industrial radiographic inspection. The recent advent of the million-volt machine with its homogeneous beam has done much for inspectors using X-rays and a close comparison with gamma rays in so far as concerns scattering can now be made. The lower voltages require filtering, diaphragming, masking and blocking of the specimen for reduction of scatter, in order that scatter densities do not obscure image boundaries. One simple means for reducing the intensity of scattering can be affected by exposing pin-hole radiographs for determination of forward transmitted scatter and back-scatter and then applying techniques to reduce its harmful effect (see the accompanying diagram).

Utilization of antimony lead foil (about 94 per cent lead foil and 6 per cent antimony alloy foil) has become a standard procedure today. Lead seems to have been selected as the most desirable filter material. It has the fortunate properties of differential absorption and differential intensification of primary and secondary radiation (proportional to the voltage). The differential is a favorable one as the undesirable scattered radiation is more strongly absorbed than is the image forming primary radiation. Also favorable is the condition that the image forming primary radiation is more strongly intensified than is the secondary. Use of the Potter-Bucky Diaphragm has been practically discontinued not because of any inefficiency, but because of the increase of exposure time required with its use.

X-ray diffraction analysis of materials has enabled the metallurgist, physicist and chemist to determine more accurately than with any other method the internal structure of and stresses existing within a given specimen. It took over fifteen years to discover that all solid crystals are perfect three dimensional gratings for X-rays by virtue of the fact that they are built in remarkably organized fashion with the atoms lying on equidistant parallel planes whose spacings are of the same magnitude as X-ray wave lengths. Since every crystal has a very characteristic ultimate architectural plan depending on the kind and number of atoms, the diffraction pattern registered on a photographic film when a fine beam of X-rays passes through a specimen will be characteristic of the particular material. With the X-ray wave length known, the actual structure of a crystal acting as a grating may be deduced.

It might be of some interest to mention that some of the larger X-ray laboratories doing the radiographic work for some aircraft producers have installed automatic exposure systems as well as processing systems in order to speed up production.

Whereas time and space does not permit going completely into the topic it is hoped the above may offer at least a mere general outline.

References:

G. C. Lawrence, Radiology Sect. Div. Physics, Ottawa, Canada, Physical Principles of Industrial Radiography, 1942.
Tobey, R. G.
Industrial Radiography, The Iron Age, Feb. 1930-March 1942.
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Screens. Jo. Applied Physics. 812. 12,836, Dec. 1927.

British Comments on U. S. Planes

(*Continued from page* 33)

HEAVY BOMBERS

Boeing B-17 (Flying Fortress)—Excellent for the work over oceans for which it was designed, the Fortress has done well in escorted raids at short range over France and should prove valuable. European weather sets a serious limit on its constant use in high-level daylight raids. American comparison between the Fortress and the Lancaster is hardly accurate. The Lancaster is faster, carries several times the bomb load and has a longer range than the Fortress. Both will be surpassed by the new Boeing B-29 and Consolidated B-32 bombers. (The Lancaster is reported to have a maximum bomb capacity of 9 tons. Ed.)

Consolidated B-24 (Liberator)—The remarks on the Fortress apply also to the Liberator.

MEDIUM AND LIGHT BOMBERS

North American B-25 (Mitchell)—A fine aeroplane, excelled only by the German Dornier Do217 which is faster and carries a bigger load.

Martin B-26 (Martian)—Another excellent aeroplane but apparently deficient in wing area. This makes operation from any but the largest aerodromes difficult with full load.

Douglas A-20 (Boston or Havoc)—A first-class machine which has given magnificent service over France and in the Middle East.

Douglas SBD (Dauntless)—An excellent dive bomber which has done great work with the U. S. Navy. Now excelled by the Curtiss Helldiver monoplane.

Grumman TBF (Avenger)—At the top of its class—the best in the World today.

Catalina & Coronado—The Catalina is a mainstay of Coastal Command. The newer Consolidated Coronado is probably the best all-round patrol boat in the World at present.

* * *

"In this brief survey," says *The Aeroplane*, "the U. S. A. is shown to be deficient in fighter development and ahead of the World in Naval aircraft and transports. The present American heavy bombers have several important tactical drawbacks which outweigh their many good features when operating in European conditions. The newer American heavy bombers should lead the World and be capable of meeting and exceeding every possible call upon them.

"On the basis of this survey, British fighter production, the present production of British heavy bombers and the future production of American heavy bombers should give the United Nations unrivalled performance in every category."

MEN

(*Continued from page* 50)

D. E. Sturm, credit manager of R. M. Hollingshead Corp. has been elected to the Board of Governors of the Credit Dept. of Motor & Equipment Manufacturers Assoc.

The following changes in executive personnel have been announced by Interstate Aircraft & Engineering Corp. **W. E. Hirtensteiner** becomes executive vice president and **Walter A. Hite,** vice president in charge of engineering, has been elected to the board of directors.

A. C. Galbraith has been appointed manager of employee counseling for all plants of the Douglas Aircraft Co.

Mirt L. Briggs has resigned as vice president of Briggs Mfg. Co. to become associated with the real estate dept. of the Briggs Commercial & Development Co.

TOUGH TO TAMPER

. . . with Bus Duct

Out of the reach of meddlers and careless workmen—well protected against sabotage—are the Bus Duct lines that distribute light and power in thoroughly modern plants.

Current-carrying bus bars are enclosed *on all four sides* by a strong, rigid casing. Even the "plug-in" openings are capped when not in use.

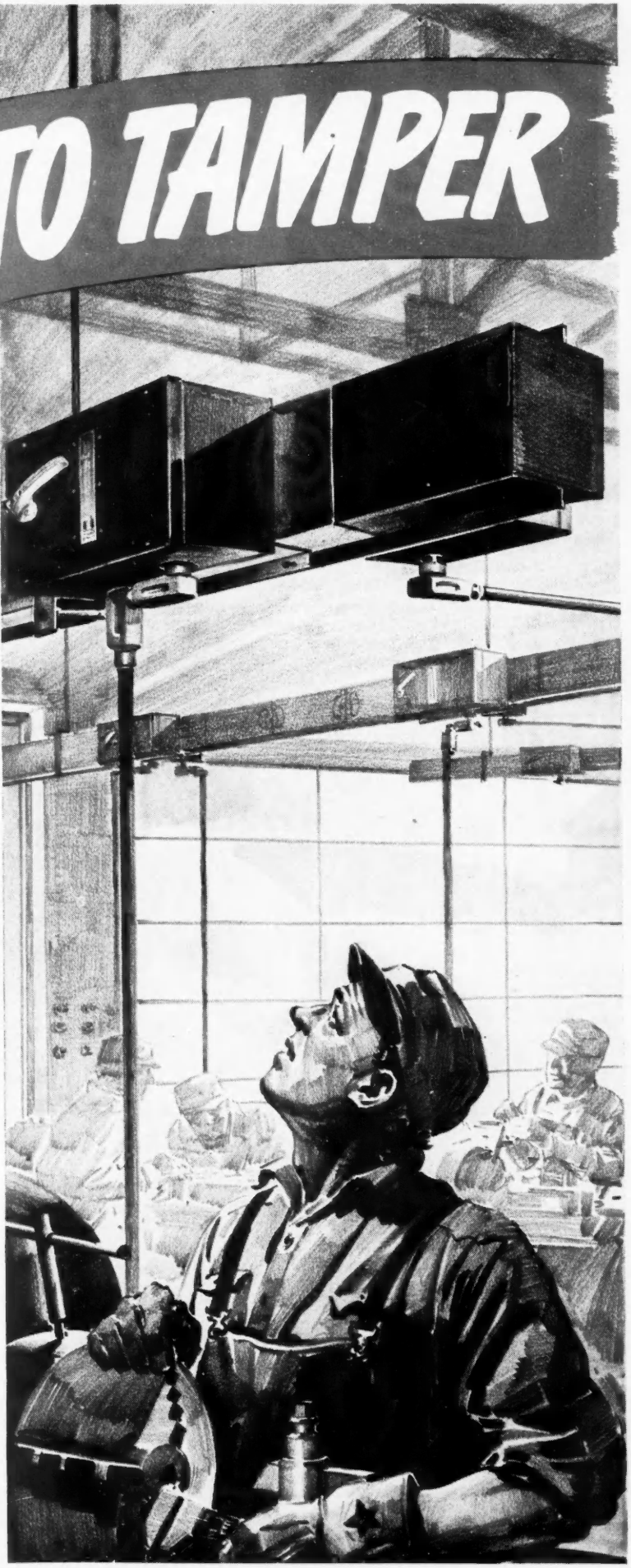
Here is *maximum* protection of property and human life — with *minimum* use of critical materials, consistent with sound engineering.

Even more important, however, are the contributions Bus Duct is making to *production continuity* in the war emergency. Machines can be moved, tool set-ups changed, new circuits added—without cutting power or interrupting work.

"Plug-in" Bus Duct systems are today recognized as an integral part of the machine tools they serve.

In thousands of plants today, they are speeding war-time output. They will be a mass production *necessity* in post-war manufacture.

BUY MORE WAR BONDS • SALVAGE ALL SCRAP METAL



BULLDOG
ELECTRIC PRODUCTS CO.
Detroit, Michigan

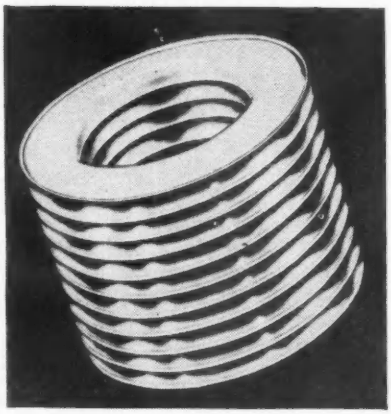
BullDog Electric Products of Canada, Ltd., Toronto, Ontario

Field Engineering Offices in All Principal Cities

MANUFACTURERS OF Vacu-Break Safety Switches, SafToFuse Panelboards, Circuit Master Breakers, Switchboards, Bus Duct Systems — FOR LIGHT AND POWER.

New Products for Aircraft

(*Continued from page* 44)



Cook "Spring Life" Metal Bellows.

struction of these universal joints which meet Army, Navy and Air Corps specifications AN 40236.

Cook Metal Bellows

Cook "Spring Life" metal bellows are constructed of individually fabricated diaphragms which are joined alternately at inside and outside peripheries. The maker, Cook Electric Company, Chicago, Ill., states that this construction permits the successful use of spring tempered metals such as phosphor bronze, steel and monel metal, and also allows the bellows to be built in large diameters. Cook bellows are being used as an integral part of automatic temperature and altitude control units for aircraft.

Asbestos Replaces Metals in Planes

To replace critical metals in aircraft production, the United States Rubber Company, New York, N. Y., has developed a line of fittings made from Asbeston, a woven asbestos fabric. They are said to be unaffected by vibration or continuous heat up to 350 deg F,

Aircraft Fittings Made from Asbeston

and are available in a large number of shapes and sizes. The fittings can be joined to ducts or hose by three methods: clamped by bands to metal sleeves inserted in both openings, cemented, or by the use of quick-grip couplings.

Lyon Hydraulic Elevating Positioner

The Lyon HYDRAULIC Elevating Positioner, made by Lyon-Raymond Corporation, Greene, N. Y., has a hydraulic tilting and hydraulic elevating table powered by a motor-driven hydraulic pump. The table is rotated by means of a hand-operated worm gear arrangement and is self locking at any point. It tilts from horizontal to vertical and is removable by taking out four cap screws, so that welding fixtures can be attached to the same top plate which holds the table. The hydraulic pump is driven by a 110 volt, 60 cycle, AC motor.

Incredible Uncle Ishmael

...the one-man army!

UNCLE ISH is the derndest feller. He paid 4½ cents for that weapon, and he can shoot a clay pipe right out of your mouth at 100 yards. What's more, he's a one-man army. . . . Incredible? Well, here are the facts:

The famous Robbins & Lawrence and E. G. Lamson companies, ancestors of Jones & Lamson, had working for them in the 1800's two of the finest gunsmiths in the world. They were Albert Ball and Benjamin Tyler Henry, and the genius of these two men contributed much to the invention of a gun that was destined to make history.

That gun is known throughout the world today as the famous Winchester rifle — but in an earlier form, as the Ball lever-action repeater, it was known only as a headache to E. G. Lamson & Co. For there was a large order from the government for this revolutionary firearm, to replace the muzzle-loaders being used in the Civil War, but the war ended before delivery could be made.

The result: Hundreds of these repeating rifles were put up for sale at one-half cent a pound—and Uncle Ishmael got one. Nine pounds of the greatest gun in the world, for 4½ cents!

Later, when the patent for Ball's lever-action magazine was purchased and combined with improvements in rifle design made by Henry and another gunsmith named King, the great Winchester rifle was born. And it was an early advertisement for this rifle that told how Uncle Ishmael was a one-man army. "A man armed with one of these rifles," it read, "can load and discharge one shot every second, so that he is equal to a company every minute, a regiment every ten minutes, a brigade every half-hour, and a division every hour!"

The company in which that famous firearm had its origin is known today as Jones & Lamson, and the gun is typical of many great American products that have stemmed from the tools — and the men — developed by this company.

Jones & Lamson engineers and service men are at your call today . . . right now . . . to help you in solving the difficult problems of present and post-war readjustment.

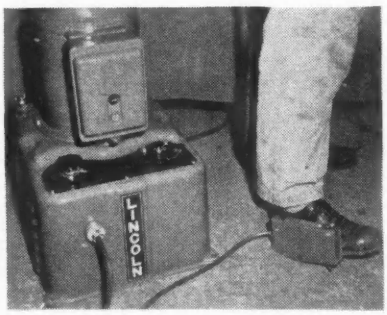
JONES & LAMSON
Machine Company
SPRINGFIELD, VERMONT, U. S. A.
Profit-producing Machine Tools

Manufacturers of Ram & Saddle Type Universal Turret Lathes . . . Fay Automatic Lathes . . . Automatic Thread Grinding Machines . . . Comparators . . . Automatic Opening Threading Dies and Chasers.

New Production Equipment

(*Continued from page* 39)

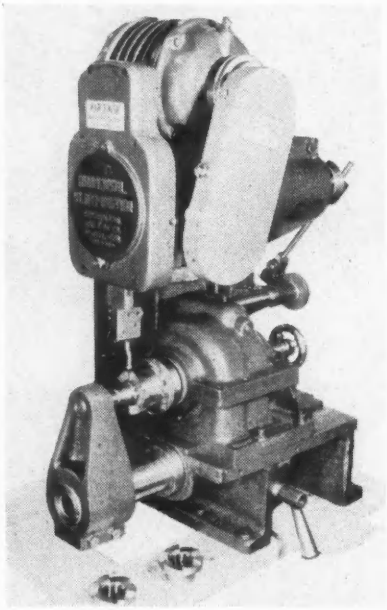
THE Lincoln Electric Company, Cleveland, Ohio, has developed a new type control, called the "Lincontrol", for use in connection with their "Shield-Arc Junior" welders. This device is strapped to the operator's foot, and enables him to move about with it freely. It eliminates the necessity of making adjustments at the welding machine to compensate for minor changes in thickness of the work or changes in fit-up.



Lincoln Electric Company's Arc Welding Control.

With the control strapped to his foot, the operator presses down on the pedal to increase the welding current, or raises the pedal slightly to decrease the current. While intended primarily for aircraft welding, the "Lincontrol" is applicable for welding light-gauge sheet metal of all kinds.

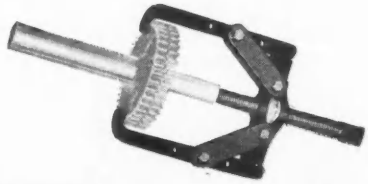
A SPECIAL slotting machine, comprising a standard "Slotmaster" and an indexing mechanism for slotting the teeth on clutch jaws, was built by the Hoover Tool & Die Company and the Experimental Tool & Die Company, Detroit, Mich. A built-in master cam feeds the part up against the special slotting tool by means of an indexing ratchet operated by the main shaft of the Slotmaster, thus the slotting strokes are perfectly synchronized with the movement of the master cam. The machine makes a complete cycle automatically, and the finished part is an exact duplicate of the master cam.



Special slotting machine comprising a Slotmaster and an indexing mechanism.

THE Wales CD Punching Units are the latest addition to the Wales line of punching and matching equipment, made by The Strippit Corporation.

(*Turn to page* 62, *please*)



The Steelgrip, a recent addition to the line of pullers made by Armstrong-Bray & Co., Chicago, Ill. The arms are heat treated drop-forged steel, and the swivel cap screws and the forcing screw are hardened steel.

More Power per Pound

GEAR CASE
Steel spindle bearing insert and steel intermediate bearing insert permanently cast in plastic housing.

GEAR CASE COVER
3 steel bearing inserts welded in cluster are permanently cast in plastic to stand maximum stress.

FIELD HOUSING
Steel inserts for housing assembly screws cast into plastic for permanency.
Steel commutator end bearing insert cast into housing. Also serves as ground connection for drill.

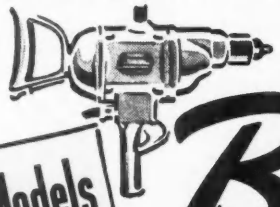
HANDLE
Steel air vents on top and bottom, pressed in housing, assure ample ventilation.

in the New Black & Decker "Drillite" Plastic Drill

BLACK & DECKER Engineers have done it again! A husky, new, lightweight drill with the *highest horsepower per pound of any drill ever produced by Black & Decker*. The housings of these 1/4" Standard and 3/8" Standard Drills—made from the modern new plastic . . . DRILLITE—were exclusively developed and perfected by eye-to-the-future Black & Decker Engineers. DRILLITE PLASTIC makes these tools a full pound lighter in weight—yet exhaustive tests prove they stand up under hard, continuous running.

DRILLITE is a perfect insulator against dielectric shock, makes the drill cooler to handle, has high impact resistance. Screened air inlets insure ample ventilation. Handsome black finish provides lustrous, modern streamlined appearance.

Ask your nearby Black & Decker Distributor for complete specifications on the Electric Drills of Tomorrow! The Black & Decker Mfg. Co., 781 Penna Ave., Towson, Md.



LEADING DISTRIBUTORS EVERYWHERE SELL

4 New Models OF BLACK & DECKER "PLASTIC" DRILLS

Black & Decker

PORTABLE ELECTRIC TOOLS

3/8" STANDARD DRILL with End Handle
Weight.....5¾ lbs.

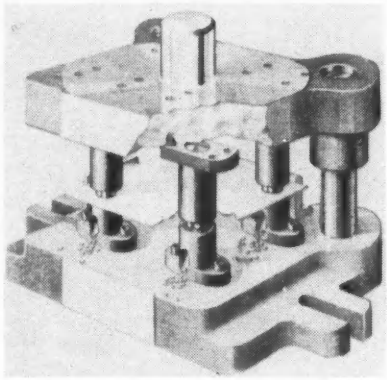
1/4" STANDARD DRILL with End Handle
Weight.....4¾ lbs.

3/8" STANDARD DRILL with Side Handle
Weight.....5⅝ lbs.

1/4" STANDARD DRILL with Side Handle
Weight.....4⅝ lbs.

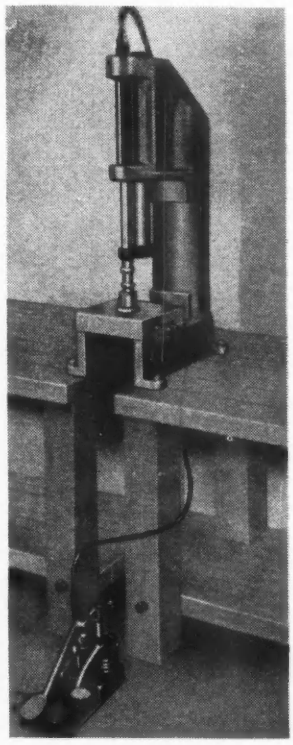
(*Continued from page* 60)

Buffalo, N. Y. They are sets of punch and die units, the punch unit half containing a punch with a pilot, a holder, a stripping spring and a guide while the die unit half consists of a holder with a slug clearance chute and a die. Each CD unit is self-contained and independently mounted to either punch or die shoe, making every punch or die holder easily accessible for changing individual punches and dies without breaking down the entire die set.



Wales Type CD Punching Units.

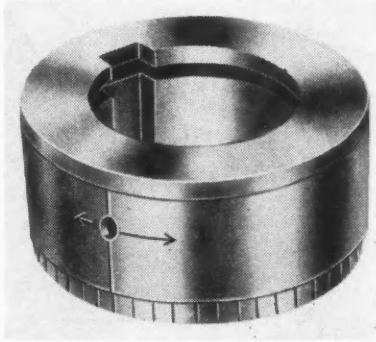
A FOOT controlled hydraulic arbor press, called the Speedpress, has just been put on the market by the Studebaker Machine Company, Chicago, Ill. A hydraulic control base, connected to the press by a steel tube, is equipped with three pedals, an applicator pedal, a booster pedal and a release pedal. When the applicator pedal is depressed, the ram moves downward to contact the work. Pressures up to



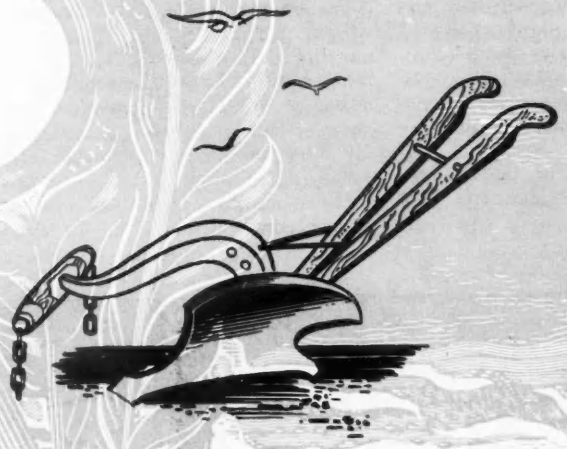
The Studebaker Speedpress.

20,000 lbs. are obtained by operating the booster pedal. The release pedal breaks the pressure, allowing the ram to return to the top of its travel.

A HEAVY-DUTY adjustable spacing collar for milling machine cutter arbors has just been put on the market by the Dayton Rogers Mfg. Co., Minneapolis, Minn. This spacing collar has a hardened and ground backing plate, and is of maximum overall width, making it suitable for use on heavy production machines. It is provided with an engraved indicator and graduated to provide adjustments of .0005 in.



Adjustable Spacing Collar for Milling Machine Cutter Arbors.



PROPHECY OF THE FUTURE . . .

THOUSANDS of small plants with war-learned efficiency will create new competition with new and better products . . . New designs, materials and methods of fabrication will produce better homes, appliances, implements and machines.

For this is the new world of the future, and our prophecy concerning it is based upon facts — such facts, for instance, as these:

• Before the war there was one magnesium and one aluminum producer in the United States. After the war there will be as many as ten magnesium producers and four aluminum producers . . . the "Light Metal Age" is being born of war.

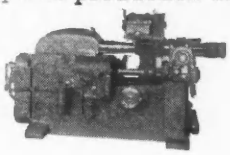
• Before the war, 200,000 rivets went into a transport plane. Today, rivetless bombers, welded throughout, have made possible a 30% increase in plane production and up to 15% decreases in weight . . . New skills and techniques are being developed by war.

• Before the war, prices were stabilized by restricting production, and buying power was down. Today, the increased earnings, enforced savings and restricted buying of our full-production war economy are creating the greatest reserve of buying power and consumer demand this nation has ever seen . . . A new *market* is being made by war.

If prosperity is to be yours after this war, the time to start your production planning is *now* . . . and in that there is one way we can help you:

Send us your internal grinding problems, and take advantage of the work which our engineers can do now to help you formulate production plans and tool up for the great peacetime future of America.

SEND FOR THE MAN FROM BRYANT



BRYANT CHUCKING GRINDER CO.

SPRINGFIELD, VERMONT, U.S.A.

Automotive Parts Makers in War Work

(Continued from page 23)

contributions has been the development of centrifuse brake drums for airplanes. Motor Wheel's conversion problem has been a typical one, since they found it possible to use existing facilities in the main, with only slight plant additions and a moderate addition to the production equipment. The wheel-assembly lines and huge press department have been adapted almost entirely for war production.

An excellent example of the conversion of automotive body plants is furnished by the Murray Corp. of America, which concern made a radical shift from body making to an entirely new line of products, employing similar equipment and similar techniques. Among the items currently produced are airplane wings, airplane wing tips, airplane nacelles, stainless steel assemblies, frames for "Jeeps," combat cars and military vehicles, parts for anti-aircraft searchlights, and "muzzle brakes" for machine guns. Although airplane work and automotive body building are quite dissimilar, there are many techniques common to both. In changing over to airplane work, Murray has pioneered many methods which have come into common use. These consist largely of an application of the know-how of steel fabrication to problems arising in connection with the forming and the assembly of aluminum parts. Initially, Murray employed the methods and the tooling of the aircraft industry. But as experience was gained, automotive methods and equipment were adopted freely. For example, the use of draw dies in heavy presses, instead of power hammers, increased the output of some parts as much as fifteen-fold. Application of draw dies to the formation of aluminum sheets was made possible by the development of the "ice-box" method of delayed aging of heat-treated sheets, stemming from the earlier method of storing aluminum alloy rivets, developed by the Aluminum Co. of America. The Murray frame division continues its automotive specialty without much change, since the product is essentially of the same character.

Briggs Manufacturing Co. is 99 per cent on war work, producing such items as airplane wings, aileron, wing-tip, wing-flap, stabilizer-fin and rudder and tail assemblies; airplane bulkheads, door assemblies, including bomb bay doors; bomber-duct assemblies, bomber turrets, shells and cartridge cases, tank hulls, tank turrets, airplane-engine parts, and non-ferrous castings.

Actually, Briggs is producing weapons of war whose general character differs widely from that of its peace-time products—automobile bodies and plumbers' goods. But Briggs had heavy-duty press equipment; it possessed the know-how of a heavy-duty sheet-metal specialist, and it was familiar also with other mass-production techniques which could be readily adapted to the new problems. This experience was found invaluable in its application to the manufacture of airplane assemblies and tank hulls.

We have in the industry an important group of specialists making piston rings, including Muskegon Piston Ring Co., Ramsey Accessories, Perfect Circle, McQuay-Norris, American Hammered Div., Sealed Power, Hastings, and many others. To these organizations the war program simply meant an intensification of activity of the same kind. However, the war in the air produced a demand for millions of airplane engine rings which, because of their size and specifications, created an entirely new problem for the major automotive producers.

In two instances—Muskegon Piston Ring and Ramsey—the addition of airplane rings created a need for new facilities. Muskegon embarked upon an expansion of its existing plant; Ramsey outfitted a new plant in Muskegon, devoted exclusively to the manufacture of airplane rings. The Perfect Circle Co. at first expanded its facilities and intensified its output; then started building an entirely new plant in Richmond, Ind., which was recently completed.

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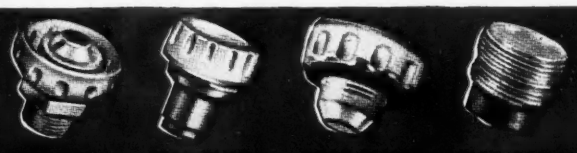

manufacture of many allied products, including pistons, cylinder liners, wrist pins, and other accessories for internal combustion engines. Its piston-ring facilities have been greatly enlarged to take care of the demand for airplane rings.

Muskegon Piston Ring also has expanded the operations of its foundry divisions in Sparta. This foundry, as is well known, has supplied gray iron castings for automotive and airplane rings to many other piston-ring manufacturers. A year ago it had no facilities for producing bronze piston ring castings, which are used for oil seals in aircraft engines and in propeller mechanisms. Since then a battery of bronze melting furnaces has been installed.

There is a human-interest story connected with war-time piston-ring developments. Up to a short time ago, the art of making rings was a closely-guarded secret, but with the outbreak of the war, the situation changed completely. The heavy demand for airplane rings overtaxed the capacity of the specialists, which made it necessary to draw in other producers. The industry responded patriotically to the call of the armed services. The leading producers banded together, pooled their hard-won technical information on design and manufacture, and made it available to the others. In the case of the Motor Transport Division, a group of independent ring manufacturers were appointed as a committee to make recommendations to the Army on a standardization program leading to the development of a set-up for the types of rings and oversizes which would best meet requirements of the Army's maintenance program.

Space limitations forbid citing further examples of the participation of the parts industry in the war effort. It would be impossible to outline the activity of the great Borg-Warner Corp., and of its subsidiaries such as Warner Gear, Mechanics, Borg & Beck, and others. Neither can we do more than touch briefly on the many, many independent parts makers and the other corporation groups such as the Eaton Axle Co., Clark Equipment, Electric Auto-Lite and its subsidiaries.

General Motors Corp. as a whole is about 95 per cent on war work. In some divisions the record is even better. For example, Rochester Products, Delco Radio, New Departure, and Harrison Radiator are on war work exclusively. The majority of the parts divisions of GM have been able to convert to war production without major plant expansions. Where major expansion has taken place, it has been due to the requirements of products completely foreign to the former activity. One example of this is the new aluminum foundry at Delco-Remy; another are the machine-gun plants at Saginaw Steering Gear and at AC Spark Plug. At Rochester Products, airplane electrical equipment has completely replaced items formerly built for automobiles. Generally speaking, however, it may be

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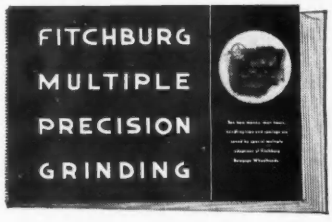

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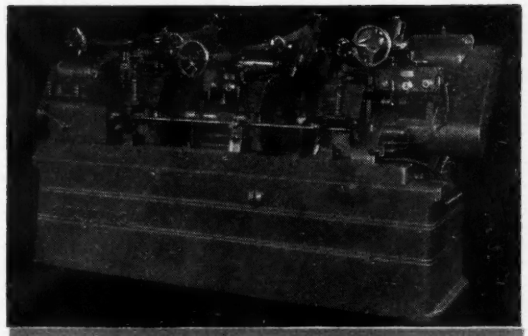
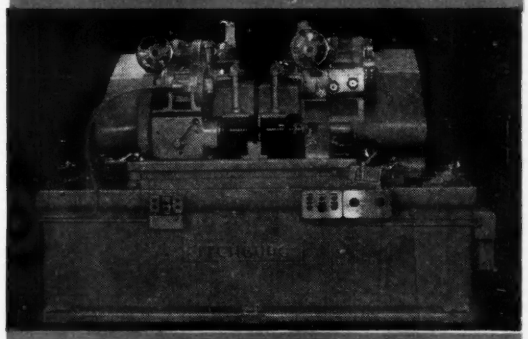
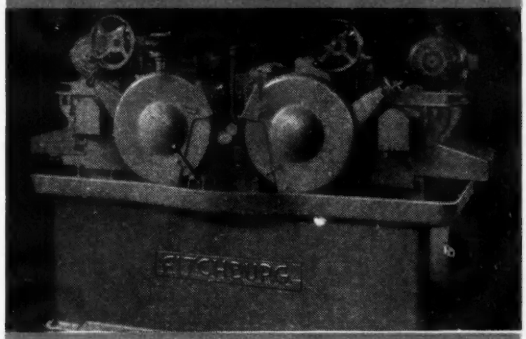


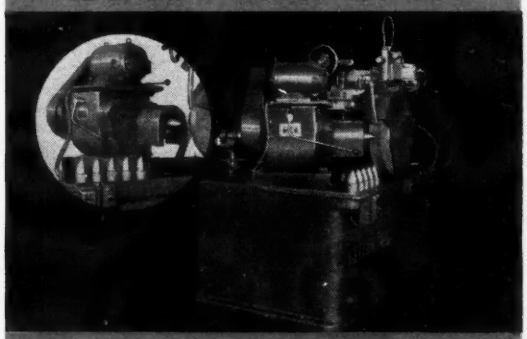
TRIPLE HEAD MACHINE



DOUBLE HEAD MACHINE



GEAR SHIFT GROOVE GRINDER



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SAVE WITH AUTOMATIC MULTIPLE PRECISION GRINDING

said that each of the divisions is producing at least certain items which are closely akin to its peace-time products. Saginaw Malleable Iron recently converted to steel castings and is specializing in the production of ArmaSteel, an alloy which has found its way into many products made by the other divisions.

AC Spark Plug has employed ArmaSteel in machine guns, reducing the number of types of steel in the gun from 44 to 15, eliminating many drop forgings in the process. Here again is an example of cooperative effort in a common cause. According to George Mann, Jr., General Manager, AC Spark Plug Co., all of the better methods, improvements, and new ideas have been freely passed along to other gun producers and to the Government. Just recently representatives of two new machine-gun plants came to AC for assistance. They were supplied with drawings for all tools, jigs, fixtures, and gages required in the program.

New Departure is 100 per cent on war work. While still engaged in the manufacture of ball bearings, this division has had to produce many new types and sizes which were completely out of the range of automotive experience. Although the existing equipment was found adaptable, it was necessary to re-tool more than 50 per cent of it. This division is currently producing about 18,000 different designs of bearings.

Harrison Radiator Division has had to shift the emphasis from some of its specialties to others. Before Pearl Harbor, Harrison was making oil coolers, cellular radiators, water coolers, air coolers, Prestone radiators, supercharger inter-coolers, heavy-duty radiators, etc. The items that constituted mass production—cellular radiators, thermostats, heaters, and defrosters—now account for only 2 per cent of production. On the other hand, the tubular radiator, which formerly represented only a small volume, is now produced in large numbers for trucks, tanks, and armored cars. Conversion has made it possible to utilize all the buildings and much of the equipment used in normal automotive production. A small amount of floor space and considerable equipment have been added.

Bendix Aviation Corp. is devoting about 97 per cent of its activity directly to war production, specializing in such items as carburetors, brakes, airplane landing gear, hydraulic units, Bendix-Weiss constant-velocity universal joints, ordnance material, airplane gun turrets, etc.

Monroe Auto Equipment Co., well-known as an automotive parts producer, particularly in such specialties as direct-acting shock absorbers and sway bars, has turned its energies to the making of projectiles, combat tank seats, etc. In fact, shock absorbers are the only peace-time product still being made. Monroe has made several major additions to its facilities to take care of the tank seat and projectile program.

W. C. Lipe, Inc., is 100 per cent on war work, producing heavy-duty clutches for tanks, an exclusive development; heavy-duty clutches for military vehicles, and many items of machine-tool equipment.

Firestone Steel Products Co., whose principal products in peace-time were wheel rims and stainless-steel beer barrels, is 99 per cent on war work. Production of heavy-duty truck rims still constitutes an important part of the volume in this plant. However, the stainless-steel-barrel activity has been converted to the production of oxygen cylinders for high-altitude flying, metallic belt links, bogie rollers, mooring anchors, motor frame bands fabricated from strip stock, rolled and welded rings, and metal stampings.

Young Radiator Co., heat transfer specialists, are devoting their available facilities to generally similar products, producing radiators, oil coolers, air coolers, etc., 100 per cent for war requirements. Manufacturing procedures have remained the same. However, a large part of the facilities formerly used for the production of heating, cooling, and air-conditioning equipment for commercial purposes has been converted to meet war needs. In addition to the normal products made by Young, they have added such items as periscope

holders, ammunition boxes, Navy spare-parts boxes, ducts and other sheet-metal parts for tanks, oil pans, frames, engine bases, etc.

Federal-Mogul Corp. is 100 per cent on war work and has added several plants turning out such products as airplane bearings and Navy propellers. Airplane-bearing manufacture has entailed not only new plant facilities, but new items of equipment, such as diamond-boring machines and extensive facilities for lead and indium-plating of silver bearings. Federal-Mogul's marine division, which formerly produced propellers for pleasure craft, has enlarged its facilities and is drawing upon sub-contractors for large propellers for the Navy and Coast Guard.

Fafnir Bearing Co. is 100 per cent on war work, producing ball bearings. Plant and production facilities have been vastly increased to take care of war demands. U.S.L. Battery Corp. reports that its storage-battery production has been reduced by one-third, due to the elimination of civilian outlets and despite the requirements of the Army and Navy.

Lamp specialists, such as Guide Lamp and the Corcoran-Brown Lamp Division of Electric Auto-Lite, served on a special committee cooperating with the War Department in the development of blackout-lighting equipment for military and combat vehicles. In addition, they cooperated in the Ordnance program for the development of the steel cartridge case.

Thermoid, which in times of peace produces brake linings, clutch facings, radiator hose, fan belts, and universal-joint discs, now turns out these same products for the military services, with certain proportions ear-marked for essential civilian needs. Looms on which Thermoid formerly made carpets for passenger cars have been converted to weave duck for the Army. Cotton webbing is now made on some of the equipment formerly used for weaving asbestos tape. Much of the industrial hose equipment has been turned to making suction hose and water hose for the Navy and for the Office of Civilian Defense. Thermoid's research and engineering talents now are directed to the improvement of the war products, to the elimination of critical materials, and to the development of new products urgently required in the war program. An example of this is a bullet-proof, rubber-covered tank of the jettison type.

Houde Engineering Division of Houdaille-Hershey Corp. has been converted 100 per cent to war work, and that without any reduction in personnel. Its war-time products include such items as landing-gear and hydraulic-actuating cylinders, aircraft nose wheel shimmy dampers, gun-recoil mechanism and shock-absorbing devices for military vehicles.

Carter Carburetor Corp., one of the leading carburetor producers in peacetime, is about 95 per cent on war production, the remainder being accounted

for by parts and service for essential civilian needs. This company found it necessary to just about double its existing facilities in order to meet the demands of the French (before Pearl Harbor), of the British, and later of the U. S. military services. Among the products made by Carter are shell fuzes, bomb fuzes, carburetors, fuel filters, and an electric pusher-type fuel pump which prevents vapor lock in military vehicles.

Timken Roller Bearing Co., Bower, and others are 100 per cent on war production. Timken is currently producing tapered roller bearings, ball gun-mount bearings, rock bits, alloy steel, etc. The burden of the war program has necessitated the addition of several plants.

Stewart-Warner Corp. is devoting its energies 100 per cent to the war, producing such new items as artillery and bomb fuzes, instruments such as speedometers and gas gages, and gasoline-operated heaters for airplanes. The normal automotive specialties are continued without change for use in tanks, trucks, buses, and military vehicles. The change-over to war production was accomplished by converting existing facilities.

Hoof Products Co., essentially a producer of governors, has swung over to war production about 90 per cent. Its latest development is a line of hydraulic-valve parts and fittings for aircraft. It has a new building program in progress.

Woodall Industries, Inc., is one of the companies that had to discontinue their normal production in the interest of the war program. This company for 23 years specialized in the fabrication of fibreboard, die-cutting and pressing into shapes and assemblies for motor cars. Experience in body engineering, equipment adaptation, die marking, and heavy-press operation built up a know-how which enabled the organization to swing over entirely to aircraft parts and assemblies, including structural framing for military airplanes, engine cowlings, and wing parts. Existing facilities were converted, and some added facilities are now under construction.

About two years ago, members of the Woodall organization visited the airplane builders on the West Coast and the company then began experiments with the Guerin process, adapting it to the forming and cutting of airplane parts with inexpensive Masonite dies in its heavy presses. This work proved quite successful, and the process has been further improved by Woodall specialists to facilitate the forming of aluminum airplane structural parts.

Tension Influences Life of Vee Belts

Conclusive evidence that the life of transmission belting and V-belts is greatly influenced by the tension factor, and that an increase in the tension over that recommended for the belt operation will result in failure of the belt long before it should break down is furnished by data from a series of tests conducted under the supervision of George H. Stewart, belting engineer of The B. F. Goodrich Company.

Three grades of the present wartime construction of transmission belting were used in that series of tests, which were run at 15 pounds per inch per ply, a 720 pound total for the tension, the recommended figure, and at 18 pounds per inch per ply, a total of 864 pounds tension, on 4-inch pulleys. Belts were all 6 inches wide, 30 feet in length, spliced in 10-foot endless lengths. Tests were all highly accelerated.

Belt No. 1 ran for 95 hours before breakdown while under the 18 pound tension, and increased its life to 230 hours before failure when the 15 pound tension was used. Belt No. 2 ran for 88 hours at the 18 pound tension, and for 263 hours before failure at 15 pounds. Belt No. 3 ran for 15 hours under 18 pound tension, and the service life before failure jumped to 48 hours under the 15 pound tension.

Conclusions reached, Engineer Stewart's report says, are that an increase of three pounds per inch per ply over the recommended tension results in the belt giving only approximately one-third of its useful service life.

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Abstracts from SAE Annual Meeting

(*Continued from page* 38)

Cabin Supercharging

THE subject of cabin supercharging in scheduled air-line operation was dealt with by R. L. Ellinger, chief engineer of Transcontinental and Western Air, Inc. He pointed out that if air liners were operated in high altitudes, above the storms and other disturbances of the lower atmospheric regions, it would make air travel both safer and more comfortable. It was generally believed that most atmospheric disturbances could be avoided by travelling at 15,000 to 18,000 ft. altitude, and the Douglas DC-1 and Douglas DC-2 therefore were designed for ceilings of well over 20,000 ft. Actual experience with these planes showed that while a lot of bad weather could be passed over, a lot more extended to still greater altitudes. Still more important was the scarcity of oxygen at high altitudes and its effect on the crew and passengers. As a result of tests and exploratory flights at high altitudes with oxygen equipment, the development and production of the Boeing Stratoliners was fostered by TWA, and a number of planes of this type were delivered to TWA and Pan American during the Spring of 1940. Scheduled operation of these Stratoliners on the TWA lines began in July of the same year. The cabin supercharging system of these air liners had been described previously, and Mr. Ellinger confined himself largely to detailing experience with the system in service.

Cooperation of Manufacturers In the Maintenance Program

PRODUCTION of the vehicles required by the Army is only half the job, said Brig. General James Kirk, Chief of the Automotive section of the Field Service; it is vehicle maintenance, the other half of the problem, that is slowing us down, and industry and the Army should work it out together. Uncle Sam today is operating a fleet of trucks that makes the largest civilian fleet look puny by comparison, and the problem of maintaining this fleet is a formidable one.

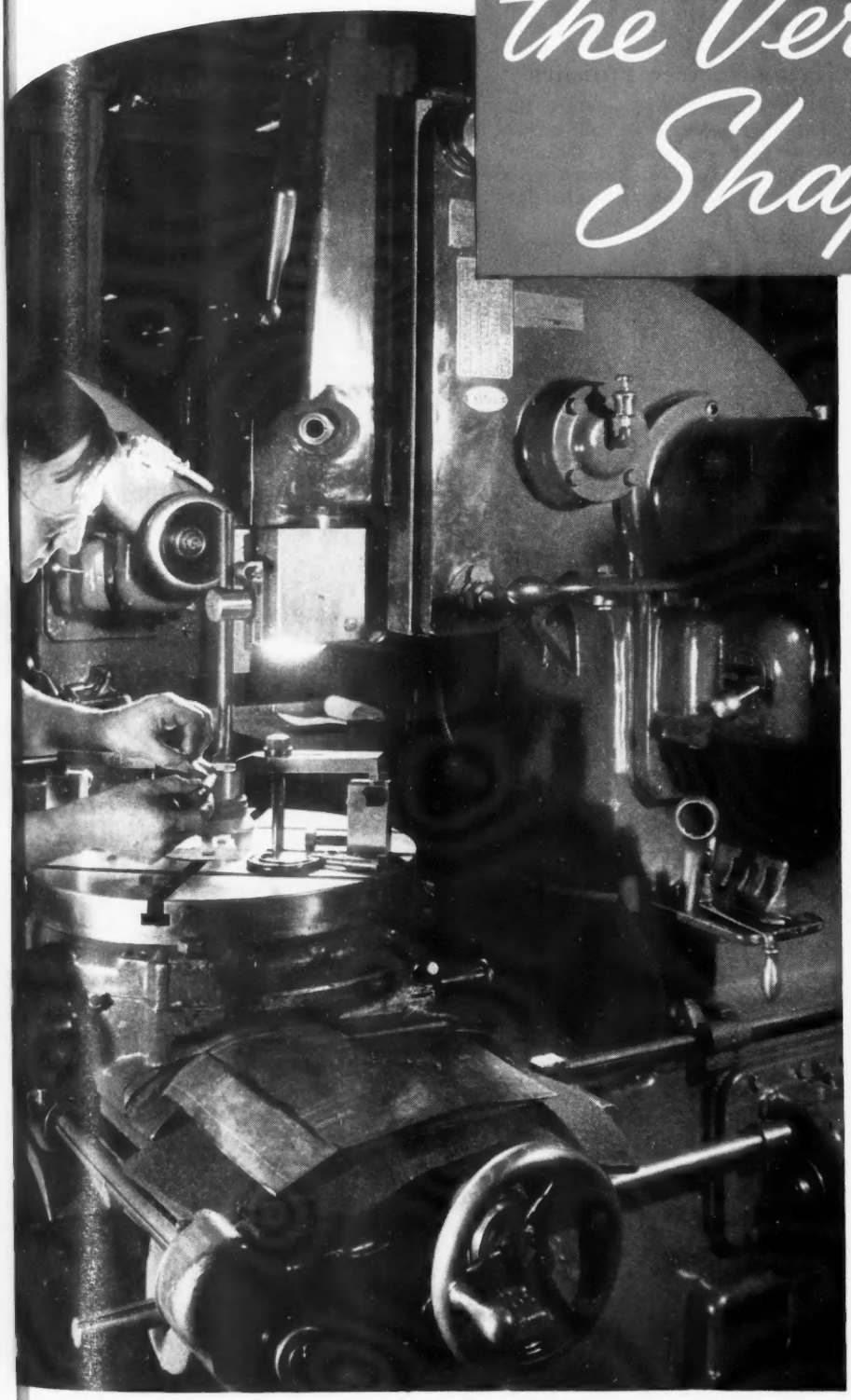
Accurate maintenance instructions should come first from the industry, because sound repair procedures can be defined and proper tools for repair specified best by those who built the vehicle. The automobile manufacturer also can best decide the method of identifying the various parts of a vehicle. As a matter of fact, different truck manufacturers using identical parts sometimes specify entirely different repair procedures. For instance, one repair manual specifies that the universal-joint drive balls should be replaced with new ones, and gives a procedure for doing the job, while another, referring to the same design of universal joint, emphasizes that not the drive balls but the whole joint should be replaced. In another case cited, trucks of two different makes are equipped with air brakes of identical make. In the maintenance manual of one truck the repair procedure covers seven pages, while in the other it is given in two paragraphs and is entirely different. Gen. Kirk said the Army wants the procedure that is most practical and wants it standardized.

The Shops and Equipment Section of the Ordnance Dept. has developed Ordnance special tool sets and Ordnance standard tool sets, and information on these tool sets is available to the industry. The Army is ready and willing to assist manufacturers in the preparation of tool lists and to aid in any special tool problems. Considerable emphasis was laid by Gen. Kirk on the inaccessibility of certain parts that must be serviced, such as spark plugs, cylinder-head gaskets, and valve adjustments, especially in cab-over-engine trucks. Too frequently, said the General, the advice of a practical service man is not sought to learn whether a contemplated design can be readily serviced.

The Ordnance Department has developed a standard nomenclature list as a method of cataloguing and identify-

"The handiest machine in the shop . . ."

the Vertical Shaper



HERE'S a machine that's the pride and joy of any good machinist who has it available. For it has an almost-human *adaptability*. It handles a vast variety of irregular shapes with a rock-bottom minimum of set-up changes. No mere slotter, it combines simple flexibility of work-holding and adjustment with refinements of non-overhanging tool head and extremely smooth ram motion.

For this is the P&W Vertical Shaper — one of many Pratt & Whitney products that provide *basic accuracy for mass production*. In tooling, it finishes complex box jigs and other high-precision fixtures. In die-making its angular ram adjustment is a welcome extra feature that permits direct machining of reliefs. It's ideal for repair work, and for small-lot production. The P&W Vertical Shaper makes tough jobs simple; its owners report they find new uses for it every day.

If you need basic accuracy for mass production, call on Pratt & Whitney. There is no better-paying investment than the right tools for each job. Details of the P&W Vertical Shaper will be supplied on request.

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ing the component parts of guns, vehicles and tanks. The next logical step is to standardize the method of listing and numbering parts of tanks, wheeled vehicles and half tracks.

Parts supply constitutes another serious problem. As soon as a new vehicle design is released for production, some member of the engineering department and a maintenance man should sit down with those who plan the parts production program and help to figure the quantity of spare parts which may be required. The vehicle, the spare parts to maintain it, and the parts list for parts identification should be available at the same time.

A start on the maintenance problem can be made at the factory. When a model is being run off in large numbers and reports come in from the field indicating the existence of some "bugs" that are causing misery to the maintenance crew, that is the time to change the design—not after the inventory has been used up.

Specifying Surface Finishes

A METHOD of specifying surface finishes of gun parts to subcontractors was explained by Harold White of Olds Division of General Motors. Six grades or types of finish are called for, beginning with coarse finish, passing through coarse and fine grind, and ending with lapped or polished finish. Two types of finish sample bars are prepared—round and flat. These are divided lengthwise into six sections, and each section is given one of the finishes called for. All comparisons are visual, no attempt being made to express the degree of roughness permitted in micro inches or other units. Two photographs are taken of each part for which a subcontract is let, in opposite directions not parallel with any flat surface thereon. These photos will show all of the surfaces for which a finish must be specified. Printed papers with six different types of sectioning on them are prepared, each corresponding to one of the finishes required. Patterns are cut from these papers to correspond in shape to the different surfaces shown in the photographs, and are pasted over them, so the operator can see at once what kind of finish is required on each surface. After a photo has been thus prepared, it can be duplicated by rephotographing.

Cartridge Cases of Steel

LT. COL. H. R. TURNER, of the Ordnance Department, U. S. Army, outlined in a paper the development work which has been done on steel cartridge cases. He said the Ordnance Department had no illusions that the conversion of such cases from brass to steel was an easy task. It was decided that the case should be made from steel in one piece by deep drawing, and the problem was attacked with the assistance of the Brown-Corcoran Lamp Division of Electric Auto-Lite Company, which had had considerable experience in making deep drawings of steel. The cases were made, but the first of them, when fired, stuck in the gun so rigidly that they almost seemed to be a part of the gun. It was then a question of determining the physical qualities required to make these cartridge cases satisfactory. In cooperation with the American Rolling Mill Co. a steel was produced which while simple in its chemistry, proved quite satisfactory. The Ordnance Department then invited some seventy manufacturers to take part in the development program, and awarded small experimental orders.

A process using cold work throughout was the method which the majority of those experimenting in the field chose as most likely to succeed. In this process, the first step is to produce a blank from sheet stock, the size and thickness of the blank being determined by the amounts of metal required for the case in its entirety and the thickness of the greatest section in the case. The blank is first formed into a cup. Following the cupping operation, the cups are drawn by conventional methods to a cylindrical section of sufficient size to produce the finished case. Following that, the cylindrical structure is formed, in tapering dies, to the final shape. Then, by machining, the accurate shape of the head of the case is produced, and

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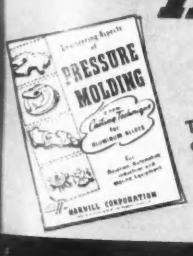

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the excess at the mouth cut off to the proper length. Spaced through the drawing operations are annealing processes necessary to restore the metal to a condition permitting additional cold work, and finally the drawn part is stress-relieved to eliminate internal stresses and produce the physical properties needed for successful functioning. Col. Turner said there is no evidence at present to indicate the necessity of heat treatment involving quench and draw processes.

Three other processes of making the cartrdige cases from steel were developed, each by a single manufacturer. In each of these processes the cup is formed while the steel is hot, and these processes were considered less desirable because the successful handling of steel in the hot state requires more skill.

Fuselage Moments

A NUMBER of investigators have occupied themselves with the problem of additional apparent mass coefficients. In a paper presented at the meeting by C. E. Pappas, chief of the Aerodynamics and Flight-Test Department of Republic Aviation Corp., the author presented theoretical cofficients of additional apparent mass for an ellipsoid of three unequal axes, and indicated the change in the theoretical coefficients due to boundary layer, interference and turbulence effects. In order to determine the effect of a viscous incompressible fluid on the additional apparent mass coefficients, wind tunnel tests were made on circular-section fuselages alone, and on such fuselages in combination with a wing. The method presented can be applied in calculating the pitching and yawing moments of engine nacelles of multi-engine airplanes.

New Materials for Aircraft Engines

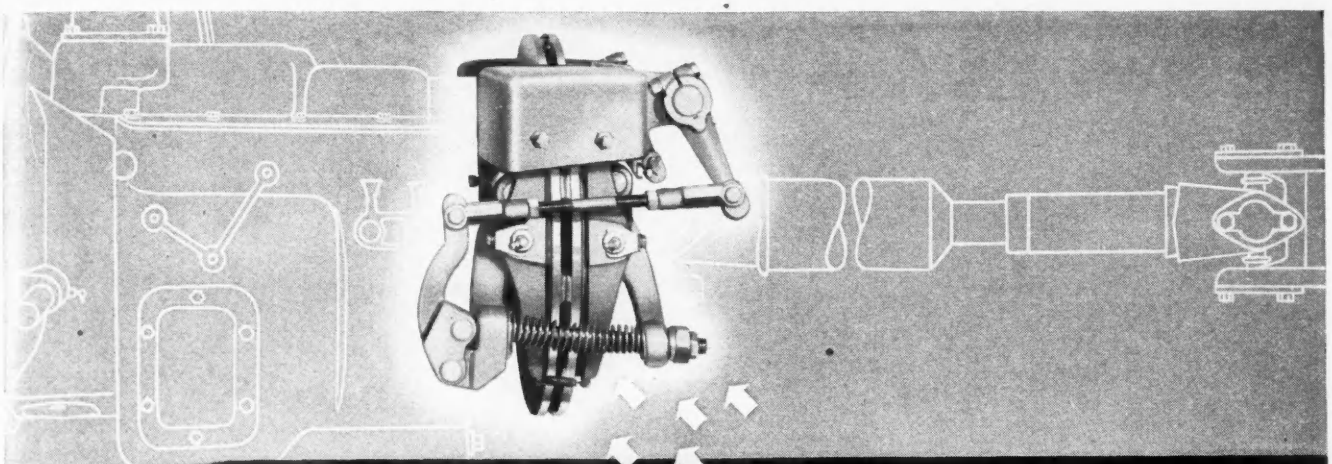
NEW materials for aircraft engines were dealt with in a paper by Mel Young and H. Hanink of Wright Aeronautical Corporation. They discussed both ferrous and non-ferrous metals, as well as a number of non-metallic materials, and since substitute metals and alloys have been deal with extensively by others and this abstract must of necessity be brief, it will be limited to that portion of the paper which was devoted to non-metallic materials.

Air baffles of air-cooled engines are now being made of cotton fabric impregnated with phenolic resins. These baffles give better service and show less breakage than the metal ones, because their greater damping capacity increases their fatigue life. They are easily formed in a press in one operation. No paint coat is necessary, as a dye is mixed in with the resin compound. This substitution saves 29.5 lb aluminum in an average engine.

Pushrod housings (tubes about 12 in. long and of 1 in. diameter) are now also made of phenolic material, whereby a saving of 4 lb of aluminum is effected per engine.

The use of moisture-impervious transparent plastic film (Pliofilm) for the protection of engines during shipment and storage is now so extensive that it deserves mention. The engine is hermetically sealed and placed in a packing box. Bags of silica-gel dehydrating agent attached to the cylinders maintain the relative humidity in the non-corrosive range. An indicator card which changes color when the relative humidity rises above the safe range is attached within the plastic envelope and permits rapid inspection through a port in the packing box. Plastic plugs containing a drying agent also are inserted in engine openings to prevent corrosion of the interior. Such plugs are of the color-indicating type, and show when they lose their effectiveness. Satisfactory reports have come from distant parts, such as Australia and Lybia, on the condition on arrival of engines protected by this method.

Military aircraft must operate in all parts of the globe and in the stratosphere. Temperature-sensitive materials, such as the rubber-type, therefore must be replaced with substitutes of a broader range. Generally speaking, synthetic rubber parts are hard and brittle at temperatures of —60 F, and vibration can cause them to shatter. A special cold-resisting Neoprene



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has been developed that will remain flexible below —60 F, but its application is limited since it will not withstand temperatures around 150 F in either oil or air, as all the freeze-resisting plasticizing oils will be leached out during oil immersion. A search is being made for materials for deflector attachments which will withstand the extremes in operating conditions. The development of fire-resistant fuel hoses within the last year has added to the safety of aircraft operation, as have self-sealing fuel tanks for military craft.

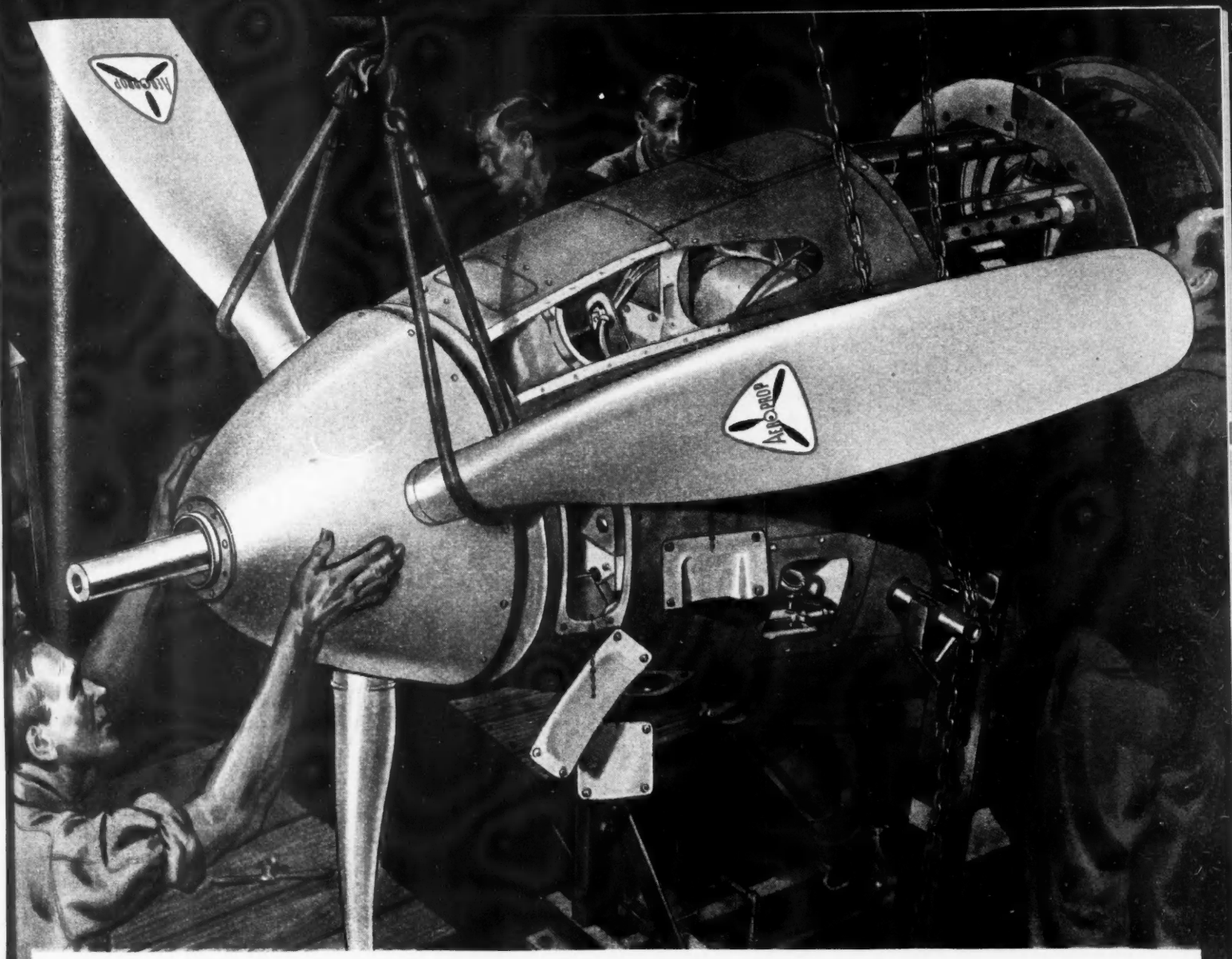
Silver is now in satisfactory use as a bearing material. As compared with the former copper-lead bearings, master-rod bearings of silver have higher fatigue strength, better heat conductivity, and greater capacity to withstand high loads. This means higher dive speeds, as in diving the bearing has a tendency to deform. Bearings made of the new material are no more expensive than the old. After the bonding problem was solved, it was found that uniform silver bearings could be produced quite easily on a number of base materials.

More care is being exercised in the selection of materials for the ignition system, and the trend is toward inorganic compounds. There has been substantial development in the field of ignition harness fillers for air exclusion; ceramics for spark plug insulation as well as for small sleeves where the ignition cable is attached to the spark plug; and in a glass-mica compound for the elbow attaching fixture.

Metal surfacing, for a variety of purposes, is finding an increasing number of applications. Coatings to prevent chafing or fretting between contacting steel parts have eliminated failures. These are applied by electroplating, as in the case of silver, or by chemical attack, as in the case of phosphate treatment. The latter provides a dull black, lightly-etched finish which is quite effective against chafing. A sulfur treatment which darkens the surface of sintered bronze clutch plates by the formation of copper sulfide has shown an improvement in the break-in quality of these parts and prevented welding of the plates in severe operation. The coating is easily applied by exposure to sulfur-bearing compounds in gaseous or liquid form. Hot aluminum spray is now used extensively on air-cooled cylinders to replace paint, with the result that corrosion resistance has been considerably increased for engines operating near salt water. In addition, it does not have to be replaced as often as paint at overhaul. Zinc shows promise as a substitute for cadmium in plating a great many engine parts, as protection against corrosion either while the part is being made in the shop or when exposed in service. Zinc-coated lockwire as a replacement for stainless steel has been tried, but has given trouble when the soft zinc is skinned from the wire at installation by pulling through studs. If so used internally, the small zinc chips could remain in the engine and cause damage.

Flash-Welding in Aircraft Production

AN INTERESTING paper on flash-welding in aircraft production, by Robert Milmoe of Lockheed Aircraft Corp., was read in the author's absence by Ed. M. Davis of Lockheed. Mr. Milmoe said that while the auto industry has long used flash-welding, the problems met with in aircraft construction are rather different, in that a great many aircraft parts are made of high-strength alloy steels with air-hardening characteristics, and that many parts are made of thin-walled tubing with a diameter/wall-thickness ratio as high as 20. In such parts a 100 per cent joint strength is desirable, besides which the weight must be held to a minimum. Flash-welding offers a number of advantages over the so-called fusion-welding processes, in that it gives better physical characteristics (100 per cent joint strength), lower weights, cheaper and faster production; it does not cause any warping of the welded parts, and it calls for less operator's skill. Joints in normalized tubing of SAE 4130 steel, made by flash-welding, show physical properties equal to those of the base metal without further heat treatment.



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One of America's finest fighting ships has earned a hard-boiled nickname — the *slugger.*

The slugger shown above is getting its Aeroprop.

You'll notice one particularly interesting fact in this production-line view of a fighter in the making. The Aeroprop is going on the ship as a single, compact unit. In a matter of minutes the complete propeller will be fully installed and ready for flight.

Thus, the Aeroprop saves installation time, but it also saves time that's even more precious. Compact unit-construction makes it possible to check and service an Aeroprop in double-quick time, and that is a big advantage at the fighting front. When the heat is on, every maintenance minute saved is a fighting minute earned.

From steel blade tip to hollow hub the Aeroprop is engineered for top combat efficiency. It is rugged, strong, light. With each passing day the Aeroprop's performance becomes an increasingly decisive factor in America's air strength — because every day more and more planes are going off the production line and onto the fighting line — *complete with Aeroprops.*

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Normalizing or annealing the joint metal after welding does not produce any worthwhile improvement. Heat treating of parts after flash welding does not impair the weld, and excellent results have been obtained with parts heat-treated before welding to show 140,000 psi, with no heat treatment after welding.

In the aircraft industry flash welding so far has been applied chiefly to tubular and solid round parts. It is extensively used to join end fittings of either the forged or machined-from-bar stock type of tubes or rods, or one tube to another. Mr. Milmoe gave the following rules for the design of parts to be joined by flash-welding.

1. Mating surfaces must be of the same shape and approximately the same cross-sectional area.

2. The cross-sectional area must be constant for a sufficient distance from the joint surface to allow all burn-off to take place in the constant-area section.

3. The welding faces should be normal to the center line of the parts, and the travel in the direction of the center line.

Parts which have been designed for arc-or gas-welding usually can be readily converted to flash-welding, though where forged end fittings have been designed for a fish-tail joint, it may be necessary to rework the forging dies. Completely finished component parts can be joined by flash-welding into a finished assembly with a tolerance of 0.010 in. However, to maintain this tolerance, the designer must provide reference points on the parts and establish the finished dimensions from points that can be used as locators on the welding machine. However, as with other operations, very close tolerances increase the cost and should not be called for when not needed.

Flashwelders intended for welding parts made of 4130 tubing must be so designed that they will be able to force the parts together at the end of the flashing period with about twice the pressure as required with ordinary steels (8000 to 10,000 psi). With this special steel the time elapsed between the cutting off of the current and the beginning of the upsetting action is quite critical. Owing to the thin walls of the tubing used in aircraft, the clamping dies must be accurately adjustable and must remain in adjustment during a run.

Production Experience With NE Steels

R. W. ROUSH of the Timken-Detroit Axle Co. presented a paper in which he detailed experiences in production with the National Emergency steels. He pointed out that in judging the qualities and servicability of these steels, use was made of the comparatively new hardenability tests, and especially the Jominy end-quench test. He gave a great deal of information on practical experiences with NE steels in different applications, and he summarized his observations as follows:

In the gear steels the 9420 is satisfactory as a substitute for 4120 and probably for 4620. It is not quite the equivalent of 4320 or 4820. For most applications reported, the 8720 has been satisfactory for these steels. In the water-hardening structural grades the 8630 can be substituted for 3130 and 4130. Judging from physical properties, it is reasonable to believe that 9430 will approach the 8630. The 9442 shows physical properties, including torsion, comparable to those of 4140.

Steels 8739 to 8749 have been very satisfactory substitutes for 3135 and 4140, and the fact that they have been deleted in favor of the 8600 series, which differs only in having a 0.05 per cent smaller molybdenum content, should not make a great deal of difference; but when alloys are reduced to the minimum, 5 points of moly. are 5 points of moly. We believe it is good judgment to retain the 8720 for gears and a number of carburized parts.

From the very limited data available on the 9600 series it appears to lack ductility. If it is used, it should be hardened to between 200 and 400 Brinell; superior heat-treating practice will have to make up for some of the weaknesses.

Some wonder why there have been

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so many changes in the NE steel specifications. The fact is that there is a lot of work yet to be done on the NE steels, especially on some of those most recently introduced, as well as on the steels treated with addition agents.

Service Conditions Faced By Military Vehicles

LT.-COL. Joseph M. Colby, who went to Cairo, Egypt, in May, 1941, for the purpose of observing and reporting on the performance of ordnance equipment in the Middle East theater of war, presented a paper dealing with the conditions under which such equipment functions in Africa. He pointed out that the failures of various campaigns in North Africa—British, German and Italian—were all due primarily to failure of maintenance. The failure of maintenance was due to lack of provision of spare parts, and failure to provide spare parts was due largely to lack of anticipation of requirements and timely requisition on supply bases. The three essential elements of maintenance are trained men, tools and facilities, and spare parts. Each of these may be reduced to a relatively simple problem. The main difficulty is that of proper coordination, and a man responsible for maintenance must have under his complete control the three essential elements of maintenance.

For a particular theater of operations there are three potential sources of parts supply. One is the zone of the interior; the second is from what is known as cannibalization of parts from vehicles which do not warrant repair, and the third is from local manufacturers.

Production Activity Session

FEATURED at the Production Activity session were an informal talk by Brig.-Gen. John K. Christmas, assistant chief of the Tank-Automotive Center in Detroit, and a paper entitled "The Conversion of the Automotive Parts Industry to War Production," by Joseph Geschelin, Detroit editor of Chilton automotive publications. Mr. Geschelin's paper is published as an article in this issue of AUTOMOTIVE *and* AVIATION INDUSTRIES. Arnold Lenz, Chevrolet assistant manufacturing executive and SAE vice president, presided at the production session.

General Christmas, whose talk was enlivened by a film showing various types of Ordnance combat vehicles in operation, credited the automotive industry with doing an outstanding job of engineering in bringing combat vehicles to their present state of development. He also praised the industry for its achievement in production planning, for its cooperative effort leading to applicable substitutes for critical materials, and for the constant improvement im manufacturing methods. Next phase, he said, is the reduction of costs by the manufacturers now that the make-ready period and volume production have been completed.

Ford Tool Shop

AN OUTLINE of the tool-shop organization and methods of the Ford Motor Co. was given in a paper by Wm. F. Pioch, chief mechanical engineer. A diagram of the organization revealed that in most respects it is similar to that of other tool rooms. However, there is in this building a clearing house which could be called the Control Center. There all orders are received and routed, and rough-stock orders are issued. A complete check is kept on all work from the time an order is received until the job is completed and shipped to the department where the production is scheduled.

American Combat Vehicles

LT.-COL. E. L. Cummings, Ordnance Dept., who presented a paper on American Combat Vehicles, listed the three important qualities of a combat vehicle as fire power, mobility and protection, and in continued operation of such vehicles the three most important factors are reliability, accessibility and simplicity.

More than 25,000 engineers and draftsmen now are working in this country to improve our combat vehicles. Before being tested in battle, new

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GRINDING WHEELS

Production Rules for EFFICIENCY

The War Program demands maximum production efficiency from men, machinery and tools. In the important field of cylindrical grinding, experience has established certain definite rules that affect grinding wheel action. A knowledge and understanding of them will be helpful and will permit more and better work.

1—The slower the work revolution the softer the grinding wheel. The faster the work revolution the harder the grinding wheel.

2—More metal can be removed in less time with the least grinding wheel wear and a minimum of power by using a soft wheel with slow work revolution taking deep cuts.

3—The harder the material to be ground the slower the work speed and the softer the grinding wheel. The softer the material the harder the grinding wheel and the faster the work speed.

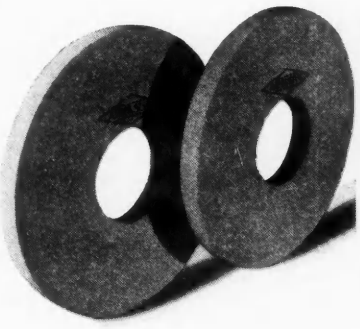
4—The smaller diameter the work the harder the grinding wheel or the faster the work speed. The larger the diameter of the work the softer the grinding wheel and the slower the work speed. Also the larger the work the greater the arc of contact which must be counteracted by reducing the surface speed of the work.

5—If a wheel appears too hard increase the work speed and if a wheel appears too soft decrease the work speed.

6—Work speeds suitable for one piece of work will not necessarily be suitable for others of the same specifications because different pieces of material thought to be the same, especially steel, are ofttimes different and as a result there is a different cutting action.

7—Cutting action will change as the grinding wheel wears smaller. Work speed and wheel speed should be changed at intervals as the cutting action changes, whether duplicate work or a variety of work is being ground.

The success of a cylindrical grinding machine operator depends largely on his ability to quickly find the best surface speed for his work, with the grinding wheel speed that is constant. Attempts to "fix the speeds and feeds" for an operation to take care of different classes of work before trial will often result in failure to produce a maximum quantity and satisfactory quality.



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models are tried out on the Packard Proving Ground at Utica, Mich.; the General Motors Proving Ground at Milford, Mich.; and the GM Testing Center at Phoenix, Ariz. All these are now run by the Ordnance Dept., which also is negotiating for the Studebaker Proving Ground at South Bend. Vehicles are tested under desert conditions at Camp Seeley, El Centro, Cal. There also is a testing depot at an undisclosed place in Canada or Alaska.

Stabilizing equipment in U. S. tanks permit them to fire accurately when in motion, which the tanks of other countries are unable to do. Sloping armor plate makes the tank more impervious to enemy fire. There is not much difference in combat between a cast or a welded tank.

Conversion of a Body Plant To War Work

DURING the first week of December, 1941, the Lincoln body plant in Detroit received orders from the Management to tool up and make the necessary changes in the assembly lines to build, paint and assemble "Jeep" bodies at the rate of several hundred per day. Delivery of these bodies was to begin in January, so that Jeeps could be assembled and delivered before February. The total number of passenger-cars which could be built had already been set by the WPB and the passenger-car body-building schedule was to begin tapering off on Jan. 23. The problem confronting the shop therefore was to make the conversion necessary to turn out the Army job at the required rate and to continue to produce passenger-car bodies in the same space. How this problem was solved was outlined in a paper on "A Body Plant Goes to War" by L. B. Rivard, chief body engineer of the Lincoln Division, Ford Motor Co.

Fatigue of Metals

(*Continued from page* 32)

visioned by the designer can exist in practice. If it should happen that two mating gear teeth are parallel at some load, they cannot be parallel at any other load, because the elastic deflection of some of the supporting parts are not linear with respect to the load. As ordinarily designed, the load on gear teeth is never uniformly distributed over the length of the teeth, but is always concentrated toward one end of the teeth. Load localization cannot often be seen by examination of a gear that has been in service because, usually, each tooth of each gear makes contact with all of the teeth in the mating gear and, therefore, the summation of all contacts under all load conditions will be seen by the examiner.

The conventional approach to studies of fatigue of metals is through laboratory tests on several arbitrary forms of fatigue specimens. During the many years that such tests have been made, a vast amount of fatigue data have been accumulated. These data have enabled us to formulate somewhat generalized "laws" on the behavior of various specimens subjected to repetitive stresses of several kinds.

All gear teeth should be designed to afford a degree of tolerance for deflections, machining errors and warpage, as has long been standard practice in spiral bevel, hypoid and in some spur and helical gears. This is accomplished by curving the teeth in such a manner as to concentrate the load near the centerline of the gear width and thus avoid load concentration at the weaker extreme ends of the teeth.

The statement made earlier in this paper that there is no practical difference, from the standpoint of fatigue, between the various alloy steels must be amended when these steels are formed into gears, because warpage is one of the many causes of error that result in high fatigue vulnerability of gear teeth. However, the fatigue vulnerability due to non-uniform warpage also can be reduced by design, as has been described.

Part Two will appear in an early issue